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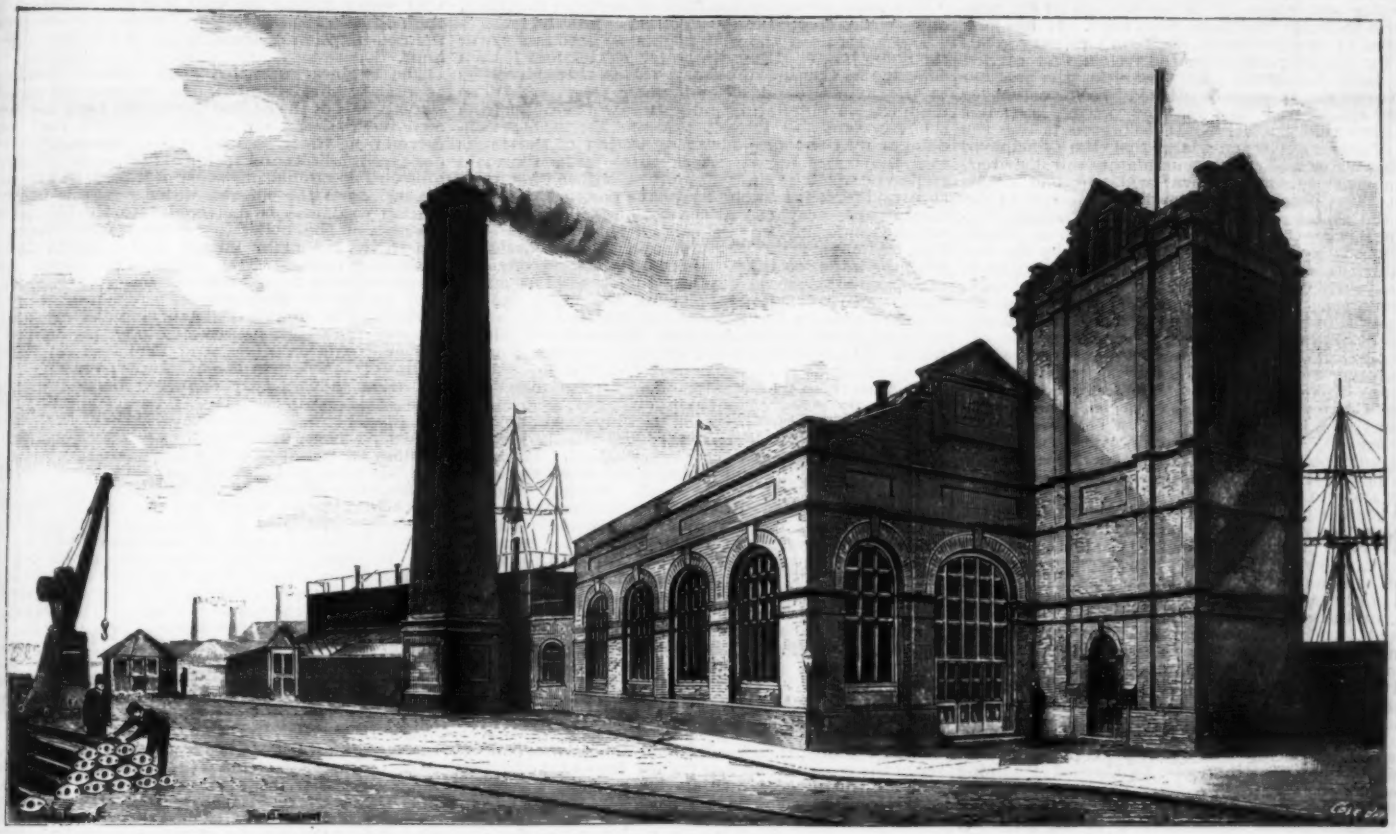


THE LONDON HYDRAULIC POWER COMPANY'S STATION, WAPPING.

"TORRENT" FILTER HOUSE, LONDON HYDRAULIC POWER COMPANY.

[FROM THE ENGINEER, LONDON.]

THE LONDON HYDRAULIC POWER COMPANY.

THERE are three principal systems by which power has until recently been transmitted over long distances; within the last few years a fourth, electricity, has been added; but of this it is unnecessary to speak at present. The three systems involve the use of steam, air, or water. Each has its advantages and disadvantages. Steam has not hitherto been used in this country, although it is largely employed in certain towns in the United States. Central batteries of boilers supply mains laid in culverts in the streets. It is probable, however, that the steam thus supplied is more used for heating buildings than for driving machinery. In Paris compressed air is largely used on the Popp system. Attempts have been made to use compressed air in this country, and notably in Birmingham; but the results have not justified the hopes of those who undertook the work. Generally speaking, it may be said that water under pressure is the best of all the non-electrical methods that have been tried. It has long been used in the dockyards, dock and railway goods yards, for working cranes on the system first carried out by Lord Armstrong. In most cities the pressure on the town mains has been utilized to some extent for working cranes and lifts, blowing organs, etc.; but we believe that to Mr. E. B. Ellington is due the credit of first applying on a large scale the principle of pumping water under an accumulator, and distributing the power so obtained over wide areas in public streets. The object of the present article is to describe the system and machinery of the London Hydraulic Power Company, the magnitude of whose operations is rendered tolerably evident by the fact that there is scarcely an important thoroughfare in London in which men may not be seen from time to time laying cast iron pipes whose enormous thickness bears ample testimony to the most untechnical passer-by that they are not ordinary gas or water mains.

The London Hydraulic Power Company, with which is associated the General Hydraulic Power Company, has been in existence for about nine years. The General Company has the same objects as the London Company, but its operations are not confined to any particular city or area. It undertakes the supply of hydraulic power either in England or abroad wherever a sufficient demand exists for a system of public supply and the general conditions are favorable.

The general principle involved is, as we have said, pumping water into mains laid in the streets, from which service pipes are carried into the houses to work lifts, or three-cylinder motors when rotary power is required. In one or two cases, however, a small Pelton wheel has been tried working under a pressure of over 700 lb. on the square inch. The efficiency is over 70 per cent., an extraordinarily high duty. Over fifty-five miles of hydraulic mains are at present laid in London between Kensington and the London Docks (Shadwell Basin) on the north side, and between Westminster Bridge and the Surrey Docks on the south side of the river, thus embracing nearly the whole of the City, Westminster, Kensington, Wapping, and Southwark. The mains are kept charged by pumping engines located at the Central Pumping Station, Falcon Wharf, Blackfriars; at Milbank Street, Westminster; and at Wapping. A fourth station is in progress in North London, close to the City road basin. The reservoir of power consists of capacious accumulators, loaded to a pressure of 800 lb. per square inch, thus producing the same effect as if large supply tanks were placed at 1,700 ft. above the street level. The water is taken from the Thames, or from the wells, and all sediment is removed therefrom by filtration before it reaches the main engine pumps.

The power is available day and night, and on Sundays, all the year round, at a pressure of over 700 lb. per square inch; a pressure which enables small machines to perform a large amount of work with a very small quantity of water.

At Kensington Court a special hydraulic supply to the houses there has been furnished by this company, in conjunction with the manufacturers, the Hydraulic Engineering Company, of Chester. Each house built on the estate is furnished with an improved passenger ram lift on Ellington's system, for domestic use. The lifts are so constructed that they can be worked with safety by even young children. The doors giving access to the lift cannot be opened until the car is at rest at the door to be opened, and the lift cannot be worked until the doors are closed.

At the present time there are over 1,750 machines at work, and the supply is about 6,500,000 gallons per week. Of the existing stations, that at Wapping is the most powerful and the most complete. It has only been a few months in full operation. The City road installation will, however, be of equal power. For the purpose of description and illustration we have selected the Wapping station, the particulars of which we are enabled to give through the courtesy of Messrs. Ellington and Woodall, of Westminster.

The water is obtained from a well sunk for the purpose. The level of the water is about 40 ft. below the surface of the ground. This well is sunk to the level of the London clay. On the top of the clay is a bed of gravel about 8 ft. thick, and the water is pumped out of the bed of gravel. The yield from the well is, when pumping continuously day and night, about 16,000 gallons per hour, and supplies about half the amount that is required at this station. The quantity required in addition to the yield of the well is taken from the London dock through a siphon pipe which discharges into the well. The pipes in the well are so arranged that the hydraulic pumps will either draw from the gravel or from the dock. There is some reason to believe that the water in this gravel bed is neither more nor less than an underground stream flowing parallel to the Thames. A hydraulic pumping engine is fixed in this well, and raises the water to a tank on the top of the boiler house. This pump is driven by water from the pressure mains. The pump was constructed by the Hydraulic Engineering Company, of Chester, under Mr. Ellington's patent, and may be thus described: The pump cylinder is fitted with a tubular plunger passing through packing at the mouth of the cylinder, and this main plunger itself forms a hydraulic cylinder, fitted with a stationary tubular plunger, through which the high pressure water passes into and out of the interior of the main plunger. On each side of the main cylinder is a small cylinder; the two plungers of these are connected to a crosshead attached to the main plunger. The small cylinders are always in communication with the high pressure water supply, which acts on their plungers with sufficient force to cause the main plunger to make its back stroke. The stationary plunger is alternately put in communication with the high pressure supply and with the discharge by means of a slide valve, which is moved to and fro by the hydraulic pressure acting alternately in a short cylinder at each end of it. The alternation of the pressure in these last mentioned cylinders is effected by the movement of a secondary slide valve, which is shifted by tappets on a rod attached to the main plunger. The speed with which the main slide valve moves is controlled by more or less throttling the passage from the secondary slide valve to its cylinders. The arrangement permits of a variation of the speed of travel of the main valve, and a pause of any desired length is obtained during reversal of the motion of the plunger.

The main plungers are 20 in. diameter, 4 ft. stroke, and work at a speed of ten strokes per minute.

The water from the well is pumped into tanks over the boiler house. Here the water settles, and is then collected by floating pipes and passes through filters to the underground filtered water reservoirs. The main engine circulating pumps draw the water from the reservoirs, and force it through the surface condensers into the filtered water section of the tanks over the boiler house. From these tanks the main engine pumps take their supply under the tank pressure, and force it into the hydraulic power mains. The total reservoir capacity at the station is 800,000 gallons, which is sufficient for one day's supply from the station. The plant for pumping and filling is designed with the intention that it should be at work day and night, while the main engines do not work as a rule more than twelve hours. During the night the hydraulic pumps in the well are worked from the power supplied from the central station, Falcon Wharf, Blackfriars. As a rule, therefore, the main engines start in the morning with all tanks full, and end their day's work with them half empty. These hydraulic pumps are not only economical themselves, but, as it will be seen, give greater facilities for working day and night, as they are quite independent of the supply plant at the particular station where they are fixed. The night watchman stops the pumps and filters when the tanks are full. That is all he has to do. We may mention that the Hydraulic Engineering Company is now putting down a large number of hydraulic pumps, made on this system, in Buenos Ayres, for pumping sewage in the low-lying portions of the town, for which Messrs. Bateman, Parsons, & Bateman are the engineers.

It is essential that the water used should be clean. The water obtained from the gravel leaves little to be desired in this respect, but that obtained from the docks is by no means pure, and elaborate precautions are taken to purify it. It will be seen from our illustration that the storage tank extends over the whole boiler house and coal store. The tank is divided, and a certain amount of mud is deposited here. From thence, as we have said, it passes through the surface condenser of the engines, and it is turned into a set of filters. Our illustration gives a front view of these filters and of the interior of the filter house.

The filters employed for rendering the water pumped from the well or supplied from the dock, as the case may be, clean and fit for circulation through the Hydraulic Power Company's mains are of the type known by the name of "Torrent Filters," patented and manufactured by the Pulsometer Engineering Company, Nine Elms Iron Works, S. W., and Queen Victoria Street, E. C. They are eight in number, and their construction may be very readily understood. The body of the filter is a cast iron cylinder, containing a layer of granular filtering material resting upon a false bottom; under this is the distributing arrangement, affording passage for the air, as described below; and under this the real bottom of the tank. The dirty water is supplied to them from an overhead tank into which it has been pumped, and is distributed to them by a pipe running the whole length of the building in which they are placed. After passing through the filters the clean effluent is run into a large tank, and is then again pumped into the clean water tank, from which the pumping engines derive their supply. The cleaning of the filters, which is done at intervals of twenty-four hours, is affected so thoroughly *in situ* that the filtering material never requires to be removed. The operation is as follows: Air is injected by a steam blower, through the distributing arrangement mentioned above, and at the same time a reverse current of water is passed through the filters; this causes the whole of the filtering materials and the impurities contained in it to boil up, as it were. The most violent agitation takes place, and the particles of dirt are thoroughly loosened by the friction of the air and water, without damage to the grain of the filtering material; the dirty water passes through cylindrical screens in the filters themselves, which allow all the impurities to pass away to the drains, while preventing the loss of any of the filtering material. After a few minutes the effluent, which at first starting is like liquid mud, becomes clearer as the air and water do their work, and regains the same tinge as the original sample to be filtered.

The water used for washing is the ordinary unfiltered water. As soon as the cleaning, which occupies but a very short time, has been effected, the filters are ready for work again. The total quantity which these eight filters are guaranteed to deal with is 35,000 gallons per hour. By a suitable arrangement of pipes and valves, a minimum of labor is necessitated, only the opening and shutting of the valves being needed, no manual labor of any kind in the washing of the filters being required. The water is rendered so clean by this process that even if allowed to remain for many days in the tall test glasses which are employed for ascertaining its purity, no deposit of any kind is to be found in the bottom, showing that all the mechanical impurities have been eliminated.

We give a general view of the interior of the engine house, a well proportioned and lofty structure, built by Messrs. J. Mowlem & Co., beneath the floor of which is an elaborate system of pipes, arranged in duplicate. The engine house contains six sets of triple expansion engines, constructed by the Hydraulic Engineering Company, on Ellington's system. The cylinders are 15 in. + 22 in. + 36 in. × 24 in. The cranks are set at 120°. Each cylinder drives a single plunger pump with a 5 in. ram, secured directly to the crosshead, the connecting rod being double to clear the pump. The boiler pressure is 150 lb. on the sq. in. Each pump will deliver 300 gallons of water per minute, under a pressure of 800 lb. to the sq. in., the engines making about 61 revolutions per minute. This is a high velocity, considering the heavy pressure; but the valves work silently and without perceptible shock. All the cylinders are jacketed, and unusual care has been taken to keep them drained back into the boilers by gravitation. The drain pipes are large and carefully laid, to prevent any accumulation of water in the bends. The steam pipes are of wrought iron, laid upon the roundabout system. Every portion is practically in duplicate. All the steam pipes are trapped, and the condensed steam from the traps is collected in a tank and returned by feed pumps to the boilers. The utmost care has been taken to prevent water finding its way into the cylinders. The engines, as a result, are found to be very economical, the consumption of steam being 14·1 lb. per horse per hour.

The engines are fitted with surface condensers, as we have already stated. The casing of the condenser forms a part of the engine frame, and each set has its own independent air, circulating, and feed pumps, driven from the crosshead of the intermediate cylinder through links and rocking shaft, as in marine engines. The circulating water is taken, as already explained, from the filtered water reservoir below the station yard, and is delivered into the filtered water division of the boiler house tank, from whence it is drawn by the main pumps and pumped into the hydraulic mains. The circulating pumps are of ample capacity to raise the necessary amount of suction water for their respective engines; they thus perform the double duty of circulating and lift pumps. The high pressure cylinder is provided with Mayer expansion slides, and regulated by hand, by means of a wheel in the usual way; the range of cut-off being indicated on engraved brass index plate. The cylinders are clothed with non-conducting composition, and covered with planished sheet steel, which is in every way an improvement on wood lagging. The engines are provided with a high-speed governor and throttle valve, and also with auxiliary starting valve.

The water delivered from the main pumps passes into the accumulators, which are among the largest constructed. We give a section of the accumulator house. This is an extremely handsome and lofty building. The rams are 20 in. in diameter, and have a stroke of 23 ft. They are each loaded with 110 tons of slag contained in a wrought iron cylindrical box suspended from a crosshead on the top of the ram. The area of each ram is 314 sq. in., and the pressure being 800 lb. on the sq. in., the total load is 314 × 800 = 251,200 lb., or a little over 112 tons. Allowing 5 per cent. to overcome the friction of the packing, etc., we have 120 tons, the extra 10 tons being supplied by the weight of the ram and the casing. One of the accumulators is loaded a little more heavily than the other, so that they rise and fall successively; the more heavily loaded actuates a stop valve on the main steam pipe. If the engines supply more water than is wanted, the lighter of the two rams first rises as far as it can go, the other then ascends, and when it has nearly reached the top, shuts off steam and checks the supply of water automatically. Although one accumulator is always in advance of the other, the difference of load is so small that both move at the same time. The result is that the pressure is maintained in the mains with very great regularity.

Steam is supplied by six boilers, fitted with economizers and mechanical stokers. The boilers were made by Mr. Thomas Beeley, of Hyde Junction Iron Works, Hyde, and are of the type patented by him in conjunction with Sir William Fairbairn, and generally known as the single Fairbairn-Beeley boiler. The boilers throughout are of Siemens-Martin steel, and each one consists of a top and bottom vessel connected by steel "blocks." The top vessel is 21 ft. long and 4 ft. 6 in. diameter, with flanged and dished ends. The bottom vessel is 18 ft. long, 5 ft. diameter, and is fitted with a flue, 3 ft. 9 in. diameter. The flue is composed of welded and flanged rings, connected by a tube plate to a battery of 3 in. tubes at the back end. This flue is fastened to the front and back end plates by bolts, the joints being specially prepared. This enables the flues to be drawn out for inspection and cleaning. To facilitate the operation a rail is fixed to the shell on which the pulleys attached to the flues run. A longitudinal dome or receiver is placed on the top of the boiler to insure perfectly dry steam. The boiler being so quick a steam raiser, this dome is advisable also, on occasion, to prevent priming. This boiler was specially designed to work at very high pressures, and we understand that Mr. Beeley has, in addition to those working in this country, many giving excellent results in France, Russia, India, and South Africa. The engraving opposite gives a general arrangement of the boilers and accessories. The boilers are fired by Vicar's mechanical stokers with movable fire bars.

The coal when delivered at the station is discharged by a 20 cwt. hydraulic crane, which raises the coal in buckets from the lighter in the adjacent dock on to an elevated staging, from whence it is run in a truck into the coal store adjoining the stokehold. From the coal store it is taken as required in a hopper bottom truck, which is raised by a hydraulic lift on to an elevated roadway over the stokehold, and discharged into the conveyer hopper, from whence it is carried to the several stokers as required.

The boilers and economizers together have evaporated 11·1 lb. of water at 146 lb. pressure from the hot well temperature with 1 lb. of Nixon's navigation coal. Combining the best results obtained on trial of the engines and boilers, the coal used per indicated horse power works out at 1·27 lb., certainly a very satisfactory and remarkable economy, on which both the engineers and manufacturers are to be congratulated.

It will be readily understood that it is of the first importance that the mains in the public streets should be so constructed and laid as to be perfectly trustworthy and free from leakage. The velocity of water flowing from a free orifice with a pressure of 700 lb. per sq. in. being about 320 ft. second, a very small hole in a pipe may lead to a large escape of power. Every

pipe and valve used throughout the system is tested to 2,500 lb. per sq. in. before being placed on the ground, and again tested to a reduced pressure in the trenches to insure the perfect tightness of the joints. The jointing material used is gutta percha, on the system introduced by Lord Armstrong many years ago, but the form of the flanges has been modified by Mr. Ellington so as to insure their being of even greater strength than the body of the pipe.

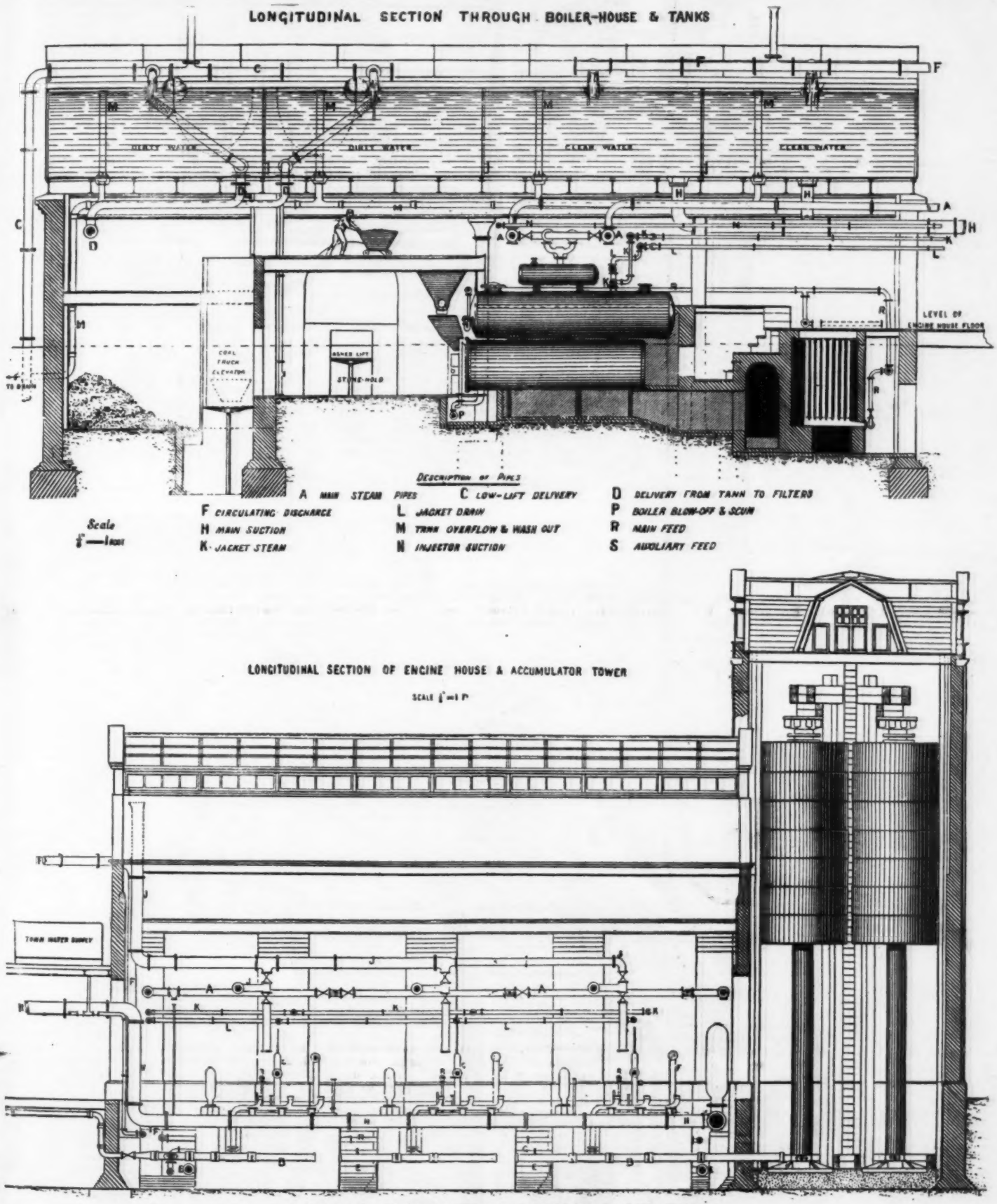
Pipes subject to high pressures, such as are employed for conveying water to work hydraulic machinery, are usually jointed as shown in the second of the diagrams on this page. When such pipes are subject to excess of pressure, or when they are overstrained in the act of jointing, they generally give way right through one of the corners. By facing the flanges of the two pipes with projecting bosses of some height, as indicated by the second section, and thus increasing the depth of the line along which fracture would otherwise take place, the pipes are made as strong at the jointing as in any other part.

Practically, no failures of pipes have occurred since this improvement was effected. At the present time there is no appreciable leakage on the system.

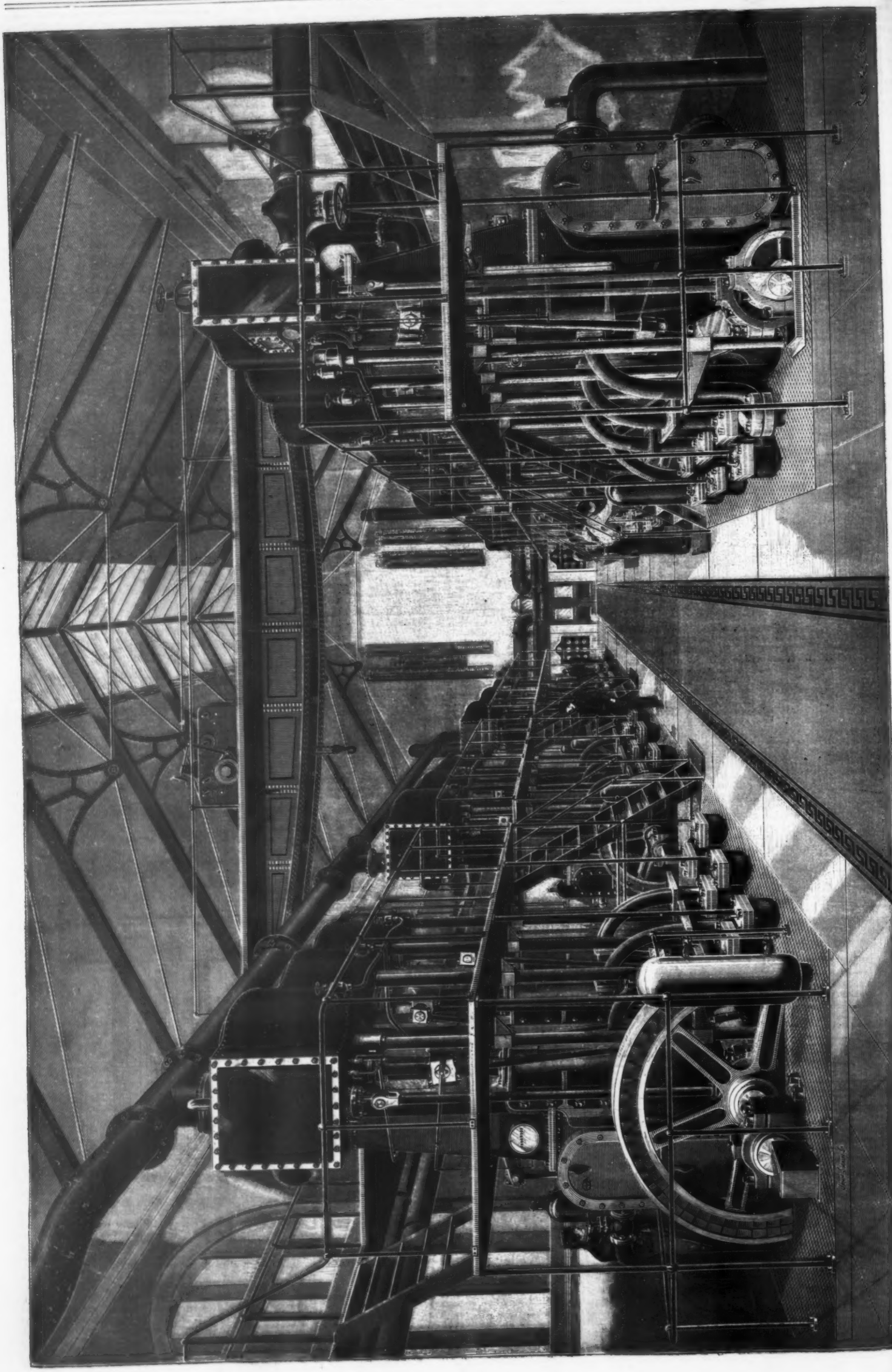
The hydraulic power is sold by meter, the charges being based on a sliding scale, commencing with a minimum charge of 25s. per quarter per machine, for which sum 3,000 gallons is supplied, and where the consumption is up to 500,000 gallons per quarter the charge is 2s. per thousand gallons. For very large consumptions the charge is still further reduced. We believe the average rate obtained by the company is about 3s. per thousand gallons. The principal use of the power is for intermittent work in cases where direct pressure can be employed, as, for instance, passenger lifts, cranes, presses, warehouse hoists, etc. For such purposes hydraulic power has been long recognized as being the best and most trustworthy. It is not surprising, therefore, to find that the Hydraulic Power Company in London has secured so large a share of the lifting work of London.

It has been proved more convenient and satisfactory than any private system of power supply, and the sliding scale of charges adopted by the company has enabled it to meet the requirements of both small and large consumers with profit to itself and the public. Circumstances differ so widely that it is not, perhaps, possible to make any general statement as to the economy of power over older systems, but in many cases proprietors of wharves have found the saving sufficient to pay the cost of the new hydraulic machinery substituted for steam or other plant in three or four years. In a great number of cases also the pumping machinery of existing hydraulic plant has been abandoned, the company's charges being found to be below the actual running expenses of the consumer's own plant. In new premises there is, of course, the large additional saving in the smaller outlay of capital required. The most notable instance of the economy of the public supply system is, perhaps, at the London Docks, where about half the power used is now taken from the company; but most of the principal railways, wharves, hotels, warehouses, and office buildings now make more or less use of the company's power. There are also a good many rotary motors at work, principally Brotherhood's three-cylinder hydraulic engine. The electric current used by the Exchange Telegraph Company is obtained from a dynamo worked from the hydraulic power mains, and, in addition to the hydraulic engine fitted up for it by the Hydraulic Engineering Company a few years ago, the company has recently fixed for it a Pelton wheel, before referred to, for the same purpose. Such a wheel is obviously well adapted for dynamo driving, and it is interesting to note that the difficulties of employing pressures of 700 lb. or 800 lb. per square inch have been overcome.

A very important use of the hydraulic power requires

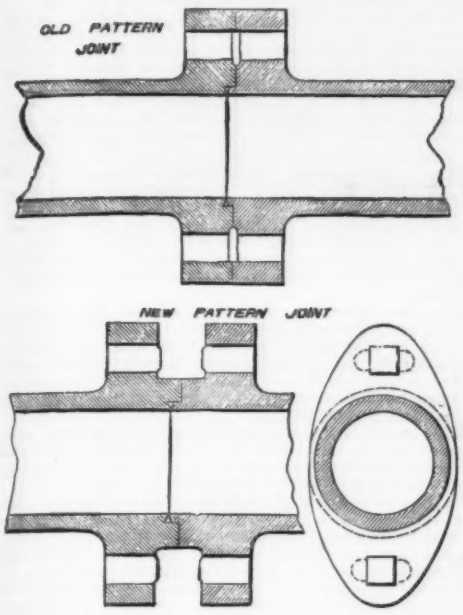


LONDON HYDRAULIC POWER COMPANY.



ENGINE AND PUMP ROOM, LONDON HYDRAULIC POWER COMPANY.

to be noticed, *i. e.*, its application to the extinguishing of fire by means of Greathead's injector hydrant; about one hundred of these hydrants are in use. Queen Anne's Mansions, St. James' Park, have them on every floor. The buildings of New Scotland Yard and the National Gallery are also fitted with them, and there are a few in the streets. Why they are not placed on all the fifty-five miles of mains of the company for public use we must leave to the London County Council to explain. By the use of these hydrants a continuous fire engine would be available in those parts of the metropolis where there is the greatest value in the most confined space; and instead of having a few feet head of water—as in the hydrants



at present fixed—we should obtain practically an unlimited head, so that each hydrant would become as useful as any single fire engine.

It is satisfactory to note that the system of hydraulic power which we have been describing is being adopted in other towns. It was first established in Hull in 1875, under Mr. Ellington's auspices; then came London in 1882, Liverpool followed in 1886, the Liverpool company being worked as a branch establishment of the General Hydraulic Power Company. The system has also been established in Melbourne and Sydney. The Birmingham corporation recently commenced to supply hydraulic power on their own account, and works have just been commenced in Manchester and Glasgow by the respective corporations. The development of this branch of hydraulics has been almost exclusively of English origin and growth, and at the present time it may confidently be stated that nothing approaching to the installation we have been describing is to be found elsewhere. The capital outlay in London has been nearly £400,000, and the dividend paid for 1891 was 5¾ per cent. The whole of the London and General Hydraulic Power Companies' works has been executed to the designs and under the supervision of Messrs. Ellington & Woodall, Westminster, the engineers to the companies. Mr. George Cochrane has been the resident engineer and superintendent in London from the commencement. The first chairman of the company was the late Sir James Allport, who has been succeeded by Mr. Henry Chapman, C.E.

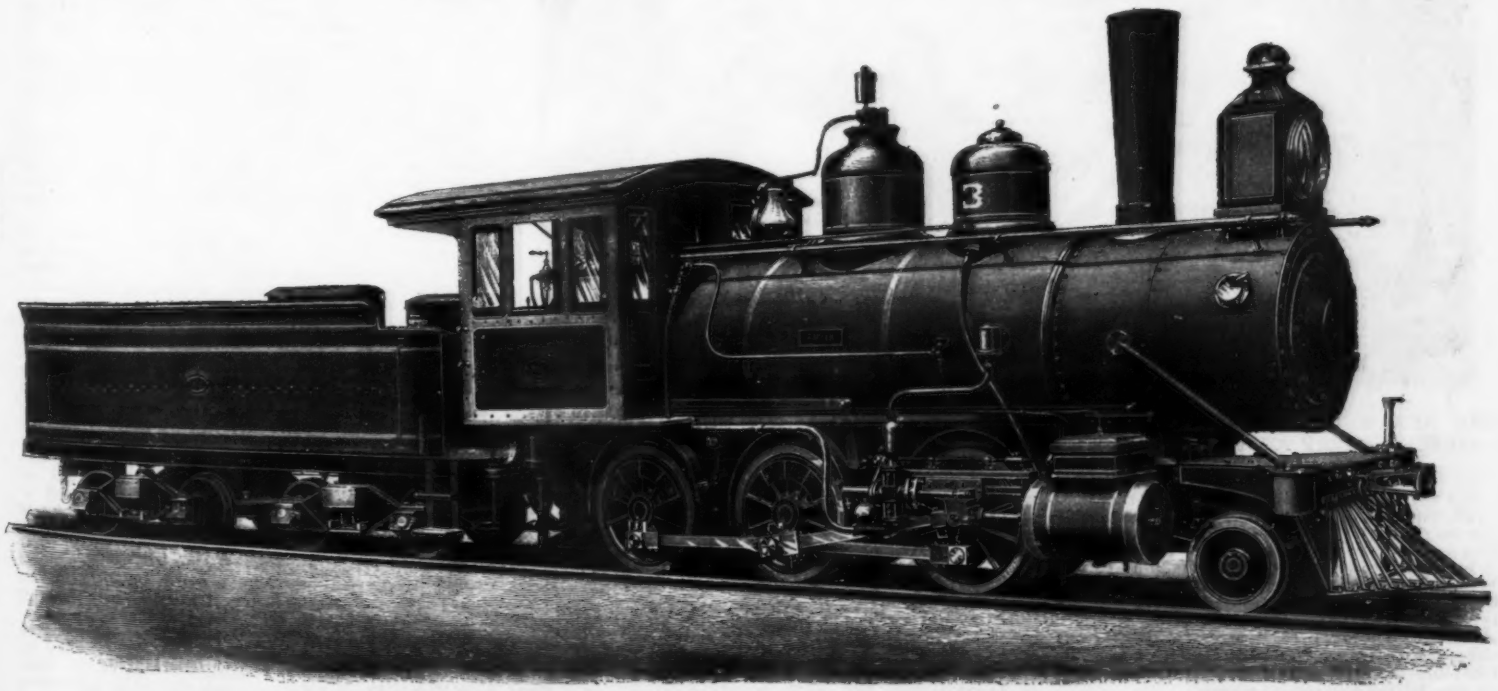
THE JAFFA AND JERUSALEM RAILWAY.

THE first railway line in Syria and Palestine, connecting Jaffa with Jerusalem, was opened on September 26, by the Governor of Jerusalem, Ibrahim Hakki Pasha, and by the Sultan's Special Envoy, Djelal Pasha, General and Aide-de-Camp of his Imperial Majesty, in presence of several distinguished officials of the Ministry of Public Works, who arrived purposely from Constantinople to witness the event, and to examine the works to see if the line were constructed in accordance with the plans and the terms of the concession. The president of the railway company and several other gentlemen and engineers arrived also from Paris for the occasion. All the inhabitants of Jerusalem and the neighboring districts gathered near the railway station; most of them were struck with amazement. A banquet was given by the railway company. The line is now open for traffic; two trains run every day from Jaffa to Jerusalem and the opposite way, passing by the towns of Ramleh and Lydda and several villages. Intending tourists may now be assured of finding comfortable accommodation on their journey to Jerusalem. Starting from Jaffa in the afternoon at two o'clock, they reach Jerusalem in three hours and a half, arriving in the Holy City before six o'clock in the evening.

In these days we consult Baedeker, who informs us that Jaffa, pronounced Yafa, is a town with some export trade in wheat, sesame, grain, oranges, silk, and soap; a landing place, of course, for thousands of Mussulmans, Jewish, and Christian pilgrims, the residence of a Turkish kaimakam subordinate to the Pasha of Jerusalem. The harbor, for small vessels only, is a basin formed by natural rocks under water and by the remains of ancient works of masonry; its northern entrance, by the mole or pier, is endangered by sandbanks, and that from the northwest is very narrow. Larger vessels and steamers anchor in the roads half a mile from the shore; passengers are landed by the boatmen. The town, built of tufa, with narrow, dusty streets, lies on a yellow beach, at the foot of a rock 116 feet high; to the north are orchards and palm trees. There is a Greek monastery on the quay, and a Latin hospice, founded in 1654, said to occupy the site of the house of "one Simon, a tanner"—but the Mohammedans claim this distinction for the site of a mosque near the Fanar, or lighthouse; an Armenian monastery, too, in which Napoleon, when it was a French military hospital, ordered the plague patients to be put to death by poison. At Jaffa, also, four thousand prisoners of war, by his order, were deliberately massacred. In the eighth century there was a Greek Church of St. Peter, on the supposed site of Tabitha's house. A German religious colony is settled at Sarona, two miles from the town. Joppa was occupied in the twelfth century by the knights crusaders, and was the scene of conflicts between Saladin and Richard Cœur de Lion. The distance southeast to Jerusalem, by the ordinary road, is about thirty-six miles. Ramleh and Lydda were towns of much note in the times of the crusades and of the Arab rulers of Syria. The city of Jerusalem has been often described.

OPENING OF THE JAFFA AND JERUSALEM RAILWAY—THE NEW STATION AT JERUSALEM.

We give an engraving of the passenger and goods locomotive Ramleh and tender, constructed by Messrs. Burnham, Williams, & Co., Baldwin Locomotive Works, Philadelphia, U. S. A., for the Jaffa and Jerusalem Railway. Five of these engines were ordered, and up to the end of November last three had been completed. They are of the single expansion type, with two outside cylinders 15 in. diameter and 18 in. stroke, and are guaranteed to haul a deadweight of 165 tons up a straight gradient of 2 per cent. The

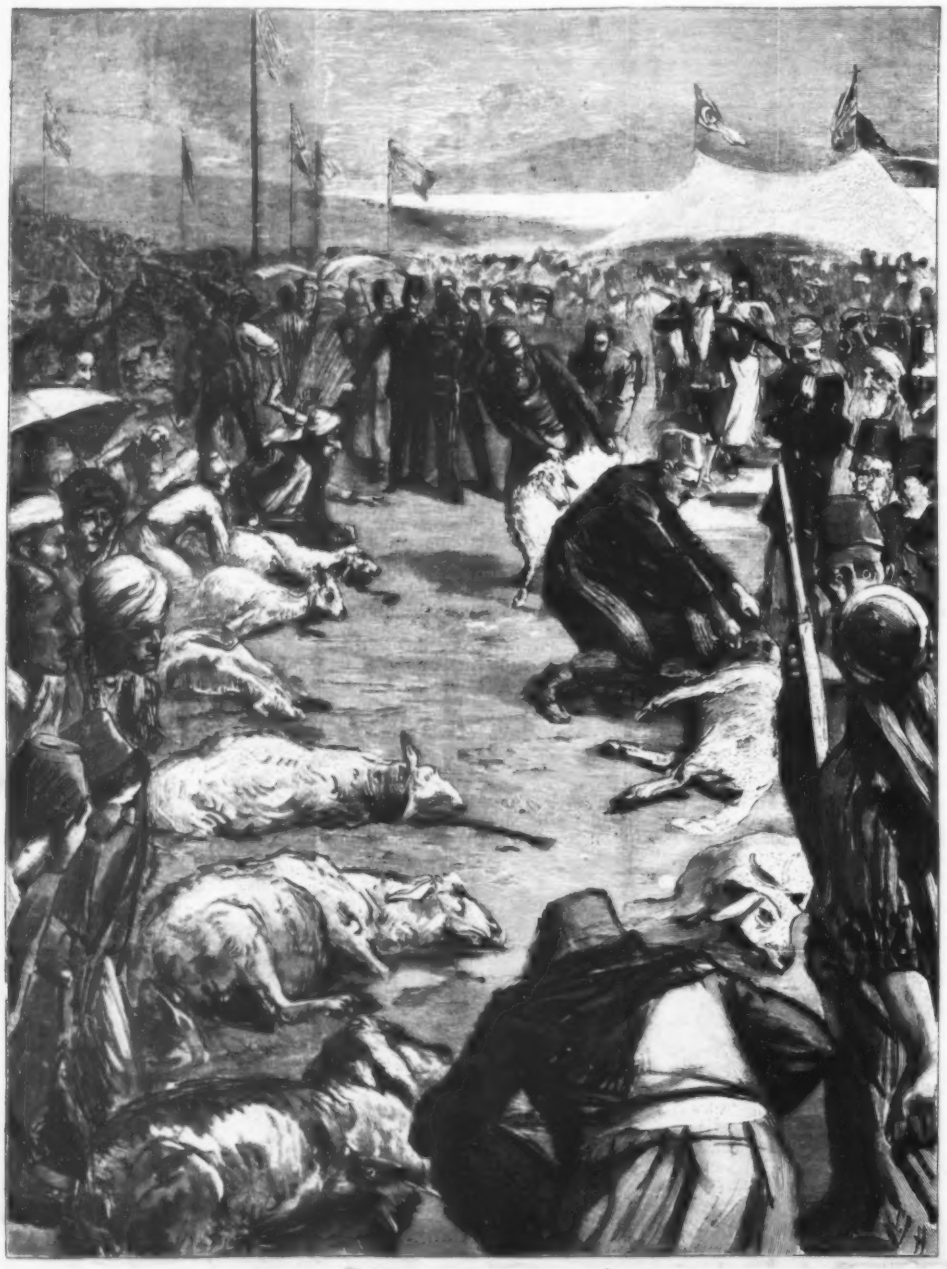


AMERICAN LOCOMOTIVE USED ON THE JAFFA AND JERUSALEM RAILWAY, HOLY LAND.

boiler is constructed of homogeneous cast steel double riveted, and the fire box crown is supported by radial stay bolts. The main frame is made of special wrought iron in two sections, and a center bearing, swiveling, two wheeled truck, with radius bar and swinging bolster, is provided for easy running round the curves. The gauge of the railway is one meter.

Below will be found a few of the leading particulars of the Ramleh:

	Ft.	In.
Cylinders, 15 in. diameter and 18 in. stroke		
Diameter of driving wheels, with 2½ in. tires	3	5
Diameter of truck wheels (steel)	2	0½
Total wheel base	16	6
Driving wheel base	10	0
Boiler—		
Length of barrel	9	0½
Length of fire box casing	6	5⅛
Width of fire box casing (inside)	2	3⅝
Diameter of barrel	4	4
Number of tubes	159	
Diameter of tubes		1¾
Pressure of steam.....135 lb. per square inch.		



THE NEW RAILWAY IN PALESTINE FROM HAIFA TO DAMASCUS—THE SACRIFICE OF FIFTEEN SHEEP AT THE INAUGURAL CEREMONY BEFORE CUTTING THE FIRST SOD.

The weight of the engine in working order is 26 tons 6 cwt. 3 qr.; weight of tender, 22 tons 6 cwt. 2 qr.; and the weight of the engine on the driving wheels 21 tons. The fire box is of cast steel, with side and back sheets ⅝ in. thick, crown plates ⅜ in. thick, and tube plate, 1½ in. thick. The water space is 2½ in. at the sides and 3½ in. front. The valve motion is of the shifting link type, graduated to cut off equally at all points of the stroke, all the parts being of special wrought iron. The slide valves are of the plain square type. The Le Chatelier water brake and a steam brake are provided on the driving and tender wheels.

The tender frame is constructed of channel iron, substantially braced, the tank having a capacity of 2,400 gallons of water, and the whole is supported on two four-wheeled center-bearing trucks. The wheels are chilled and are 26 in. diameter.

In addition to the railway now in operation between Jaffa and Jerusalem, another railway in the Holy Land has been projected, namely: From the port of Haifa to Damascus. This enterprise is under French auspices. The ceremony of turning the first sod was lately celebrated according to Mohammedan customs, on which occasion fifteen sheep were sacrificed. One of our engravings represents the slaughter of these innocent creatures. We are indebted to the *London Illustrated News*, to *Industries*, and to the *London Graphic* for our illustrations.

RAILWAYS OF GREAT ALTITUDE IN THE ANDES.

IN a preceding article we have examined the influence of climatological conditions upon the health of travelers in the exploitation of the lines of great altitude that now traverse the high plateaus of the Andes, and we shall now have a few words to say about the *materiel*, properly so called, and the precautions that have been observed in the construction of these remarkable lines.

The extreme rarefaction of the oxygen in the air evidently helps to protect organic matters and metals against oxidation. The excessive dryness of the air acts also on its part to prevent any fermentation, and in this regard Mr. Legrand cites cases of numerous bodies of animals and even human remains that were preserved in a thoroughly dry state until they finally were resolved into dust and were carried away by the wind. The rare plants of the desert, says he, furnish no humus, the fallen leaves dry up and are converted into a white powder that surrounds the stalk as if with a heap of ashes.

It will be at once seen how rapidly assemblages of wood must be affected under such conditions. So it was foreseen that it would be necessary to definitely dispense with wood and replace it in all cases with metal in the construction of buildings as well as in the rolling stock of the railways, and in the ties.

On another hand, one of the principal difficulties that is met with in the construction of lines of great altitude is connected with the necessity of protecting them against the whirlwinds and the avalanches of snow that occur in the country during the greater part of the year (for about eight months). It thus becomes necessary to construct artificial tunnels or snow sheds that are sometimes of great length. The expense of constructing such sheds often exceeds that of the piercing of tunnels in the rock. Mr. Legrand estimates that the artificial tunnels of the transandine line that we shall speak of further along reach a length of from 50 to 60 kilometers.

We meet, moreover, as well known, with analogous artificial tunnels or snow sheds, but of less extent, in North America, in the crossing of the Rocky Mountains.

We have already mentioned the four principal lines that traverse the Andes at the extreme limits of the inhabitable atmosphere, and we shall now add a few details as to the country traversed by the two lines from Mollendo to Punho, and from Antofagasta to Uyuni, and shall dwell more especially upon the last of them, which is to completely traverse the American continent from Valparaiso to Buenos Ayres.

The line from Mollendo to Punho traverses (starting from Mollendo) a burning desert upon the sides of the volcano Misti, which forms a nearly perfect cone dominating the country by an altitude of 5,700 meters.

On the first night the train stops at a distance of 150 kilometers, and at an altitude of 2,300 meters, at the station of Arequipa, a curious ruined city whose cracked edifices bear witness of the disastrous activity of the volcano.

The second nocturnal station is at Viscovaya, at an altitude of 4,500 meters, in a region almost constantly invaded by snow or frost. The terminal point, Punho, is situated on a small bay of Lake Titicaca at an altitude of 3,923 meters. This lake has an area of 8,000 square kilometers. It contains several islands, among others the sacred island of the same name as the cradle of Manco-Capac and of Manca-Oella, his wife, the first Incas. Navigation upon it is quite dangerous, and is assured by means of two small steamboats that were carried thither in light sections and with the greatest difficulty.

The line from Antofagasta to Uyuni prolonged to Oruro, and which is ultimately to reach La Paz, the capital of Bolivia, is the one that has, as we have already said, the greatest extent in these extreme altitudes, and is, besides, of peculiar interest, because of the great difficulties that were met with in the crossing of the desert of Atacama.

This desert is rich in mineral matters and silver and copper mines. Deposits of guano also are met with therein; but in the greater part of its extent the earth consists, in a manner, of true lakes of borate of soda. It is absolutely dry and destitute of all vegetation. No fuel is found there, and water itself is entirely wanting. It is therefore impossible on the line to burn any other coal or consume any other water than that carried by the trains themselves, which are the sole purveyors of these desolate regions. At the epoch of Mr. Legrand's voyage there was at Antofagasta no other water utilizable for the boilers than that distilled from the sea, and this is what was afterward distributed along the line for the requirements of the exploitation. A line of water mains 315 kilometers in length, which was then in course of construction, and which must now be finished, will permit of remedying these grave difficulties in a certain measure.

The crossing of certain regions of the desert, especially in the section from Salar del Carmen to Sierra Gorda, is exceedingly painful, even for the passengers in the train, on account of the torrid heat that must be endured, the rays of the sun reflected by the uniformly white soil of the desert striking the sides of the car, which advances in a true furnace. At other points, at the approach of night, the temperature becomes exceedingly cold, the earth restoring to the atmosphere the excessive heat that it has absorbed during the day. There is everywhere the same bare and arid aspect of a congealed sea of borate of soda, without any vegetation.

The track is established with a gauge of 76 centimeters. The gradients that it presents scarcely exceed 30 millimeters per meter. Among the constructive works may be mentioned the Conchi viaduct, at an altitude of 3,000 meters, at a distance of 300 kilometers from the origin. It is an iron bridge of 240 meters' opening that crosses the valley of the Loa, and that may be considered, by reason of the difficulties of construction that were met with, as one of the most remarkable of the world.

None of the lines that we have just described completely traverses the Cordilleras, nor can afford communication by rail between the two sides of the great chain of mountains.

The same is not the case with the last line, that of Central Chile, which is to run, when finished, from Valparaiso to Buenos Ayres through the chain of the Andes, and thus, for the first time, to connect, in South America, the coast of the Pacific Ocean with that of the Atlantic.

This line comprises three principal sections: (1) That from Valparaiso to Santa Rosa de los Andes at the foot of the chain, and the length of which reaches 136 kilometers; (2) the central, unfinished, section running from Santa Rosa in Chile to Mendoza in the Argentine Republic, through Uspallata, and which includes the crossing, properly so called, of the Cordilleras, and is 240 kilometers in length; (3) the section running from Mendoza to Buenos Ayres through Villa Mercedes and San Louis. This latter section is 1,200 kilometers in length and is now in operation, as is also the first section, which traverses an important part of Chile.

In Fig. 1 is represented the direction line of the central section, which is the most interesting of all, by reason of the great technical difficulties presented by the establishment of a railway in desolate and scarcely explored regions. It must be added, too, that at the time of the melting of the snow, the valleys are traversed by impetuous torrents that rend the rocks and carry huge blocks with them and crush everything on their passage, thus rendering it necessary to further consolidate the line by exceptional works.

The crossing of the chain is to be effected through a series of five tunnels, which are separated only by lateral galleries and ventilating chimneys, so that they in reality constitute a single tunnel 13 kilometers in length. This tunnel, situated at an altitude of 2,300 meters, will be the most elevated one that exists in the world after the Denver & Rio Grande, in the United States, which is at an altitude of 3,415 meters. The width of the track is uniformly one meter. The two extreme sections, one extending from Los Andes to a distance of 25 kilometers on the Chilean side, and the other from Mendoza to a distance of 135 kilometers on the Argentine side, have no gradients of over 25 millimeters. The central section, only partly finished, extends from kilometer 125, starting from Mendoza, to

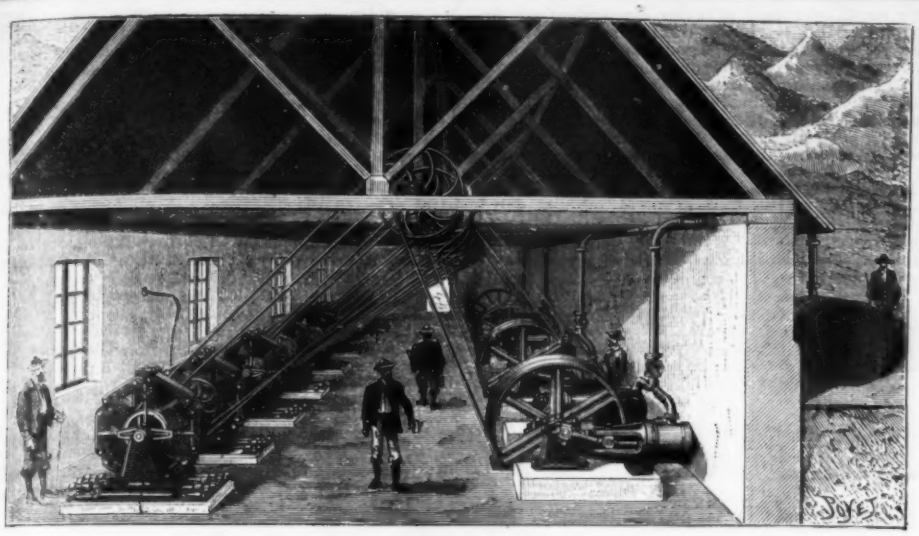


FIG. 2.—COMPRESSION WORKS AT LAS CUEVAS—INTERIOR VIEW.

kilometer 205. It presents gradients of 25 millimeters in simple adhesion and of 80 in rack. This section is to be operated by mixed engines of the Abt type, which might be applied likewise upon the two extreme sections.

The work of construction, especially as regards the piercing of the tunnels, has, as we have above stated, presented exceptional difficulties, and we have thought it of interest to give a few details on this subject from an article by Mr. Schatzmann, chief engineer of the line, published in the *Revue Generale des Chemins de Fer*.

Starting from Mendoza, as far as to the Cordillera, the line follows the course of the Rio Mendoza (which it several times crosses) in a narrow and tortuous valley, and the torrential nature of which has necessitated considerable rockwork to protect the embankments against the exceptional freshets. Beyond Uspallata, at kilometer 91, it reaches the valley of the Rio Blanco, which it follows as far as to kilometer 135. This part is one of the most arduous of the line, because of the continual falling of the rocks and the necessity of providing against freshets. So too, in the central part, it has been necessary to protect the line against the very frequent avalanches of snow by the artificial tunnels that we have before mentioned.

In order to diminish the length of the line in the central part, which occupies 70 kilometers, the rack has been adopted upon eight sections, representing a total extent equal to a half, say 35·87 kilometers. In these parts the work of construction is less important than in the other sections, by reason of the special facilities given by the adoption of the high gradients compatible with the rack in order to adapt itself to the relief of the ground. It is evidently the characteristic advantage of this mixed arrangement.

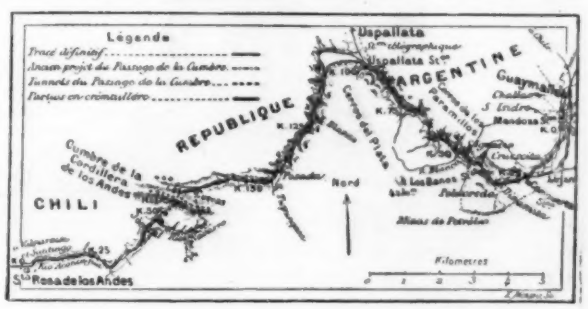


FIG. 1.—CENTRAL SECTION OF THE LINE FROM VALPARAISO TO BUENOS AYRES.

The Chilean simple adhesion section extends, as we have said, from Rio Blanco to Los Andes. It has a length of 25 kilometers, with a maximum gradient of 25 millimeters. This section has required important constructive works, necessitated in part by the numerous irrigating canals that it traverses. It crosses the valley of the Aconcagua by means of four tunnels pierced through a rock of extraordinary hardness, and of a viaduct and a bridge. The crossing of the Cordillera constitutes the most important work, and we shall dwell upon this more especially. It is to be effected through a long compound tunnel, in reality five tunnels, each having its own mouth. This arrangement permits of multiplying the attacking fronts, and will thus greatly hasten the advance, which is necessarily limited in a region where the rarefaction of the air enormously diminishes the effective work that the laborers can perform. In addition to the attacks of the head of each tunnel, which were begun December 5, 1889, with the Cumbre tunnel, there are arranged nine lateral galleries rejoining the direction line and increasing the number of the working fronts. The work was suspended on December 1, 1890, in consequence of the financial difficulties in which the Argentine Republic was involved. The advance made to this date was 1,300 meters, giving a mean of 24·71 meters per month of normal attack.

The piercing was effected by the means of compressed air rock drills of the Ferroux type. The motive power was furnished by turbines, actuated by water derived from the mountain torrents, and it was led to the various working points under the form of electric energy. Upon each side of the mountain is established a true electrical plant, in which these turbines actuated dynamos that furnished the motive current. The latter was transmitted to the receiving dynamos commanding air compressors, which furnished air under the necessary pressure to the rock drills. The installation of these plants at an altitude of 2,200 meters, in desert regions unknown up till then, is not one of the least curiosities of the construction of this audacious line. On the Chilean side the electricity was transmitted to a distance of 7 kilometers, and on the Argentine side to a distance of 3 kilometers.

According to Mr. Schatzmann's calculations, this arrangement, complicated only in appearance, which in reality gave the installation a great pliancy, assured, nevertheless, a relatively high rendering. The minimum was 0·654, and ought to have reached 0·7, according to the constructors.

The plant of the Chilean side is established at Juncal, at 7 kilometers from the working points. It furnished a power of 800 horses, which actuated two stations of compressors that ran sixteen drills, and, at the same time, gave the energy necessary for the accessory operations—electric lighting and various transmissions in the plant. Every drill absorbed, in normal time, a power of 25 horses, which was reckoned at 30 in order to provide for unforeseen exigences. The elements of power, turbines, and dynamos had been fixed at 80 horses in order to have machines of a weight easy to transport.

The water was led into the motive works by twin conduits of a length of 1,320 meters, giving a head of 170 meters, which assured to each turbine a rotary

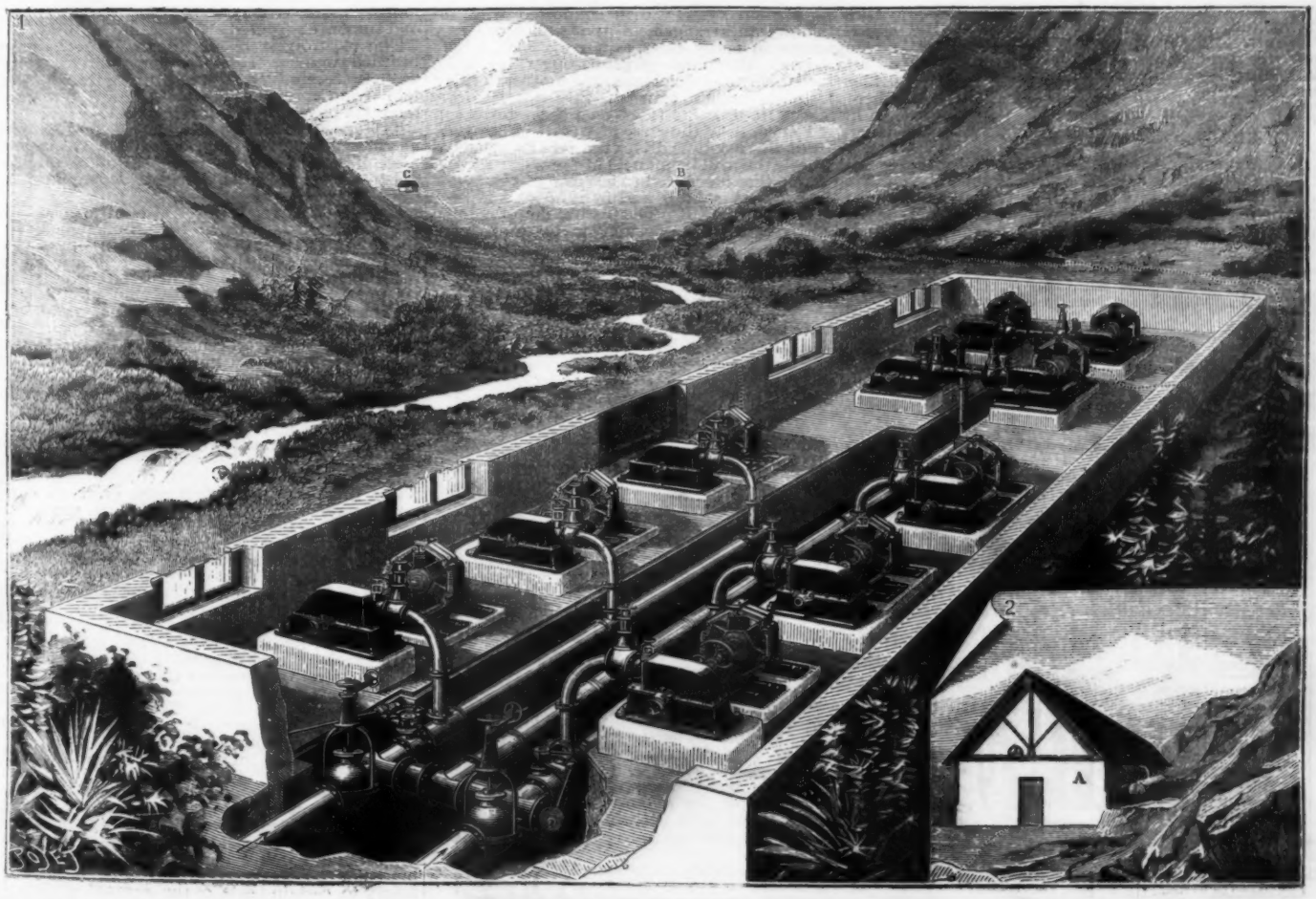


FIG. 3.—ELECTRIC PLANT AT JUNCAL.

velocity of 700 revolutions per minute, equal to that of the dynamo that it actuated, thus permitting of coupling them upon a single shaft.

The installation of the Juncal motive works at the altitude of 2,300 meters is represented in Fig. 3. We have supposed the roof of the building removed in order to show the interior. In the corner of the engraving we give an external view of the compression works, of which Fig. 2 gives an interior view. The motive works consist of a building 26 meters in length by 10 meters in width, containing ten 80 horse power turbines coupled directly to ten dynamos of the same power arranged symmetrically on each side of the conduit and united in two groups, one of six machines for the Juncalillo station, the compressors of which actuate ten rock drills, and one of four, that of Calavera, which runs six.

The transmission of motive power is effected through three independent circuits, corresponding to three automatic regulators that act upon the turbines. These latter are of the Escher-Wyss type, with horizontal axis, with 0·6 meter wheels, and with gates regulatable by hand.

The electric cables are of insulated copper wire covered with lead. They are buried in the earth to a depth of 0·3 meter, so that they may not be exposed to the violent tempests of these elevated regions. The Calavera cables comprise 19 wires of an effective section of 175 square millimeters. They are capable of supporting 1,600 volts.

In the terminal station, the receiving dynamos of 60 horse power actuate, through an intermediate belt, four groups of air compressors of two cylinders each, running at the rate of 180 revolutions per minute. Finally, a small special dynamo of 10 horse power assures the electric lighting. The air furnished by the four groups of compressors is stored up in a reservoir from which starts the tunnel conduit running to the drills. These latter are united, six in number, upon one carriage in common weighing five tons, the displacement of which, despite the slope of 80 millimeters given to the gallery to facilitate drainage, is obtained by means of a small compressed air windlass. The running pressure of the drills is five effective kilogrammes.

On the Argentine side, the installation adopted was founded upon the same principle, and we shall not dwell upon it. The motive works installed at Navaro comprise four turbines, giving 80 horse power at 600 revolutions. These actuate eight generating dynamos of 40 horse power coupled two by two upon the turbine shaft, on each side of it.

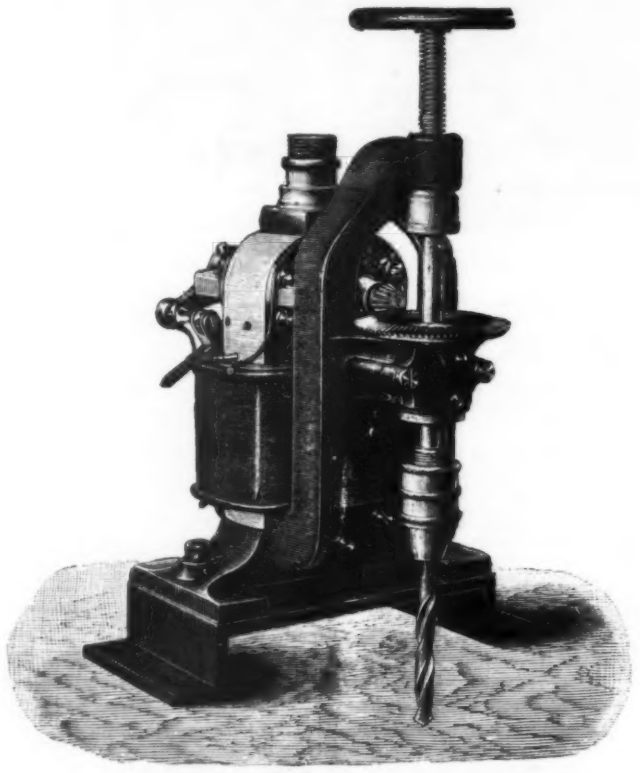
The compressing works, at three kilometers distance, at Las Cuevas, comprise eight receiving dynamos of 30 horse power, and four groups of compressors. Besides, a 10 horse power dynamo supplies the electric light. It was not possible to adopt the 60 horse power dynamos, as upon the Chilean side, since they could not have been transported. These works are represented in Fig. 2. There is reason to think that the work of tunneling will not be soon resumed; but incomplete as it remains up to the present, for causes entirely foreign to technical considerations, the work none the less does great honor to all the collaborators, engineers and laborers, who have pursued the execution of it at the cost of the severest fatigue and amid difficulties that might have seemed to be insurmountable. It merits being classed among the most remarkable constructive works of the engineer of our epoch.—*La Nature.*

THE ELECTRIC RAILWAY IN NEW ZEALAND.

THE illustration given herewith shows Princes Street, Dunedin, looking south, with the overhead electric railway in operation. From advices from New Zealand, we think there should be a fair demand in the immediate future for electrical apparatus.—*Electrical Engineer, London.*

ELECTRO-MAGNETISM.

THE measurement of the intensity of an electro-magnetic field is a matter of great practical difficulty. However, as the movement of a wire in any magnetic field tends to set up a current in the wire, and as the field may be that of a permanent magnet, or even that of the earth, and since, also, the strength of any field is proportional to the number of its lines of force per unit area, while the current generated in a wire is also proportional to the number of lines of force cut by it, and to the rate of cutting, we may compare the strength of different fields by observing the current resulting from the cutting of them by a wire at equal speeds. It is advantageous to wind the wire into a small coil and place it in the field with its plane perpendicular to the direction of the lines of force, and then suddenly turn it through a right angle, when its plane will be parallel to the lines of force, and none will be passing through the coil. The E. M. F. resulting will be proportional to the number of convolutions, the strength of the field and the area of the coil (that is, to the number of lines of force passing through the coil), and to the speed with which the lines are removed. Special galvanometers are constructed to give the values of such sudden momentary currents, by comparing which the strengths of the various fields can be measured.—*Electrical Age.*



IMPROVED ELECTRIC DRILL.

IMPROVED ELECTRIC DRILL.

OUR illustration shows a drill connected with an electric motor; an arrangement that will prove very advantageous in many cases, as, for instance, where objects having very large circumferences are to be drilled (there being no special machines for this work) or where it is undesirable to transport the piece of work.

A little electric machine is set on a base which can be screwed on or near the piece of work. The armature shaft of this machine drives the drill by means of conical wheels, the drill being held in a properly formed bearing frame that is screwed to the foot of the motor under the coils. A spindle and handwheel serve for pressing the drill forward. The electric motor is to be connected by wires of the desired length to any convenient dynamo or accumulator. The great usefulness of this machine in places where there are electric light plants will easily be understood.—*Uhland's Technische Rundschau.*

VIEW OF PRINCES STREET, DUNEDIN, SHOWING ELECTRIC RAILWAY.

ELECTRICITY IN MEDICINE.

THE enormous strides made by the new force in commerce and industries of late years have been to a certain extent paralleled by the application of electricity in medicine and surgery. The electric motor turns the drill of the dentist, bores out all the noses of mankind in the hands of the rhinologist, and may run the saw and the trephine of the surgeon. The electric light is made to illuminate all the cavities and interiors of the human body, so that "the pestilence that walketh in darkness" in the black recesses of our viscera is sought out and driven away by the electric search light. It is nothing now to put an endoscope into the stomach and scrutinize its walls from one end to the other, and in a dark room the very size of the stomach is determined by the translumination of the abdominal walls when a light is turned on inside of that viscus.

Electricity furnishes heat for the cautery, with which morbid surfaces may be healed, wounds stimulated, and tumors extirpated.

The electrolytic needle removes the hairs of the bearded women, eradicates birthmarks, decomposes tumors, coagulates aneurisms, and in its most romantic role manufactures those most desired ornaments of feminine physiognomy, lovely dimples.

The electromagnet pulls out the beam from our neighbor's eye, when the beam is in the shape of a piece of iron, and when the operation is intelligently directed by the ophthalmologist. It may hunt up and draw out wandering needles.

One of the new features of electric medication is the introduction of drugs into the human body through the skin. This is done by placing solutions of any drug upon a sponge, which is made the positive pole and placed against the skin. When the current is turned on, the drug is actually driven through the skin into the tissues. The application is not at all painful. Thus cocaine has been driven in over a painful nerve, and neuralgias have been relieved by it. Many other drugs have been used in this way. This property of electricity is known as cataphoresis. Operations have been performed after anæsthetizing the skin and subjacent tissues cataphoretically.

The neurologist perhaps finds a large therapeutic field for electrical exploration. With the continuous current he soothes the pains of peripheral nerves, calms down an excited brain, stimulates healthy processes in a diseased spinal cord, exercises paralyzed muscles, rejuvenates overworked limbs, and aids in the rebuilding of tissues in members that have wasted away. Sometimes he calls into his aid the interrupted and the alternating currents, and occasionally takes into service the static sparks evolved from his big glass wheels and Leyden jars. The method of the working of electricity in disorders of the nervous system is much more obscure than in the maladies mentioned above, where heat, light, electrolysis, and cataphoresis produce effects at once apparent to the senses. Not able to demonstrate objectively the value of electricity in some of the chronic nervous diseases, a great deal has to be accepted on faith. There is dispute in some quarters as to its intrinsic value here, and many incline to the idea that suggestion has a good deal to do with improvement in patients of this kind treated in this way.

Besides its employment as a therapeutic agent, electricity has considerable value as a means of diagnosis in many neurological conditions. For instance, the resistance as measured by the rheostat is reduced in exophthalmic goiter and increased in hysteria. The muscular contractions produced in paralysis from injury to certain parts of the nervous system are so different from contractions produced by electricity in paralysis due to lesions in the brain, as an example,

that their differentiation constitutes an important aid in distinguishing these affections one from another. Then, too, in the surgery of the brain and spinal cord which has newly sprung into existence, electric stimulation of parts of the brain and of nerve roots is very valuable in localizing the exact region to be operated upon. Indeed, much of our knowledge of the localization of functions in different parts of the surface of the brain is owing to electricity made use of by physiologists in their marvelous experimental researches in cerebral domains.

Altogether electricity occupies an extensive place in the armamentarium of the physician. All parts of the human economy are explored by its beneficent light, and there is no cell so secretly hidden that it may not be influenced by this wonderful force, which may be made to penetrate skin, muscle, bone, blood, nerves, and viscera. No one can yet place a limit upon its possibilities as a remedial agent, for each year new apparatus, new devices, new forms of current, and new methods are made available to the medical profession in its noble warfare against the diseases which assail mankind on every hand. It is not in vain that men have sometimes looked heavenward for aid in sore affliction, for has not the lightning been drawn from the clouds to become his friend and heaven-born ally? —*N. Y. Sun.*

THE ENGINEERING DETAILS OF THE NEW YORK-CHICAGO LONG DISTANCE TELEPHONE LINE.

By JOS. WETZLER.

UP to the time at which the New York and Chicago line had been contemplated, the longest sustained successful telephonic transmission had been about 500 miles, and it was, therefore, a matter of no small consideration, and one the importance of which the American Telegraph and Telephone Company well recognized, that the operation of a line almost twice this distance should be successful at the very start. The previous experience of the company stood it in good stead, but the rules which had been laid down for the calculation of the size of wire required for the transmission of speech had been found to be at such variance with the actual practice of the company that its engineers were necessarily obliged to observe the greatest caution in their recommendations. The most commonly accepted rule for telephonic transmission is that laid down some few years since by Mr. W. H. Preece, which is as follows:

When K R	= 15,000,	speech	impossible.
" "	= 12,500	"	possible.
" "	= 10,000	"	good.
" "	= 7,500	"	very good.
" "	= 5,000	"	excellent.
" "	= 2,500 or under,		perfect.

This rule, it must be pointed out, is entirely empirical, and as such, as frequently turns out to be the case, is only safely applicable to circuits whose length is within the limits of those by which the rule was formulated. As proof of this, we may remark here that the telephone line between London and Paris was built according to this rule, and the K R constant of 7,500 was adopted. When the line was finished it was found that transmission over it was very much better than the formula indicated, which went to prove that the rule apparently did not apply to that particular line. But long before the completion of the Paris-London line it was well known to the engineers of the Long Distance Company that this rule was not generally applicable, for the reason that the circuits at their command showed that transmission was possible over lines having a very much higher K R constant. Thus among the experiments tried by them was the coupling up of lines aggregating in length from 650 to 1,100 miles. The results obtained are shown in the following table:

650 miles,	transmission	excellent..	K R=31,000
750 "	"	good.....	K R=45,000
885 "	"	poor	K R=62,000
1,100 "	"	none.....	K R=91,000

These experiments were made with a "solid back" transmitter and three cells of Fuller battery, the usual equipment of the long-distance telephone set.

According to the formula enunciated by Mr. Preece, it would require a wire weighing nearly 2,000 pounds to the mile in order to communicate with Chicago, and it was not to be wondered at, therefore, that the engineers of the Long Distance Company hesitated in applying this rule. The result of their own experience, however, was such as to give them confidence in the selection of a greatly reduced size of wire, and after due consideration it was determined to select a No. 8 B. W. G. wire, having a diameter of 0·165 inch and weighing 435 pounds to the mile.

This wire has a resistance of 2·06 ohms per mile and a capacity of 0·0158 microfarad per mile, with wires strung 35 feet above the ground. The thousand miles practically representing the distance between Chicago and New York has a K R constant of 32,000. Yet, notwithstanding this enormous excess over the limiting figure laid down by Mr. Preece, it was adopted and the line built. The results obtained are now well known, but even before the building of the line was begun the engineers of the company were firm in the conviction that it would prove to have such excellent speech-transmitting qualities that it would give a sufficient margin to make it possible to add on other lines at the end, and possibly secure communication to cities beyond Chicago, such as Minneapolis, St. Paul and St. Louis; while, on the other hand, it would leave large margin for the attachment of local lines within a radius of 100 miles from Chicago.

As another proof of the inadequacy of the transmission formula, as laid down, it is only necessary to consider the following K R constants for lines which are now, and have been for some time, in daily operation as follows:

Boston and Washington.....	K R = 26,250
Boston and New York	K R = 12,100
New York and Philadelphia	K R = 2,000

From the above it is evident that, while the lower figures given by Mr. Preece agree thoroughly well with the results obtained on the long-distance lines, the higher figures are greatly at variance with it, the circuit between Boston and Washington, for instance, exceeding Mr. Preece's figure for speech "impossible" by nearly 75 per cent.

As some question might be raised as to the manner in which the K R constant is here calculated, it might be well to point out the fact that Mr. Preece multiplies the total resistance of the circuit by the capacity of one of its wires measured against its mate, and estimates that the capacity of one wire measured against its mate is one-half of what it would be if measured to ground. In the calculations made by the long-distance engineers they have taken the resistance of one of the wires of a metallic circuit, measured in ohms, and multiplied it by its electrostatic capacity measured in microfarads to ground. The difference evidently is one of method only, the result being the same. It might be well to point out here that one wire measured against its mate, as done in the calculations of Mr. Preece, is never found to be exactly one-half of the capacity when measured to ground, being usually found to be from 60 to 65 per cent. of that quantity.

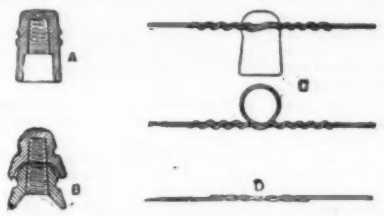


FIG. 1.—DETAILS OF CONSTRUCTION ON THE NEW YORK-CHICAGO TELEPHONE LINE.

The building of the line having been determined upon, the questions of the details of construction to be adopted were given most exhaustive study. In this respect the experience of the company in its past work has also stood it in good stead, with the result that it is fair to assume that the construction adopted will afford a line of the most permanent character.

The line is built of standard poles 35 ft. long, of the best quality of live green cedar wood peeled, and the knots trimmed close. This length of pole permits it to extend not less than 26 ft. above the surface of the ground. The cross-arms employed are of thoroughly seasoned, straight-grained Norway pine, 10 ft. long, 3¼ in. thick and 4¼ in. deep. These cross-arms are given two thorough coats of metallic paint, and are braced with two galvanized iron braces, which are attached to the cross-arms by means of galvanized iron carriage bolts. These cross-arms are fastened to the pole, not in the usual way, by means of fetter drive screws, but by a galvanized iron bolt, the pole being bored for the purpose, and the bolt passing entirely through. Washers under the head and nut prevent abrasion of the cross-arms and the pole.

The insulator pins are made of clear split locust, 1¼ in. in diameter. The type of insulator employed is the regular standard white glass American Telegraph and Telephone Company's insulators (A, Fig. 1). For the guard wire the 20 oz. Western Union double petticoat insulator, without petticoat, is used. The transposition insulator is of the Hibbard pattern, of white glass, and is shown at B, Fig. 1.

On the corner poles guard irons are employed. Every tenth pole is furnished with a lightning rod made of No. 6 galvanized iron wire. These rods are fastened to the pole every two feet by iron staples extending from the top to the bottom, and at the latter end they are given two hand turns. In ordinary good ground the poles are set at distances of 130 ft. to a depth of 6 ft., and on curves to a depth of 6½ ft. The method of tying the wires is shown at C, Fig. 1. Here it will be noticed that one side of the wire passes around the line wire and makes five complete turns. The joints in the copper line are made with McIntire sleeves, each sleeve being given three complete twists, as shown at D, Fig. 1.

In laying out a telephone line great care must, of course, be taken to avoid cross talk and other disturbing influences, which militate so much against clear enunciation, and make wires noisy. For this purpose it is necessary to transpose the wires at proper intervals, and to accomplish this transposition insulators are employed. Fig. 2 shows the method of carrying out the transposition. It will be noted that the line coming from the left is dead-ended on the upper insulator, and continued by means of a cross-over connector to the neighboring line, its mate. This line is also dead-ended on the other upper insulator. In the same way the other two sides are joined, so that the position of the conductor on each side of the cross-arm is reversed.

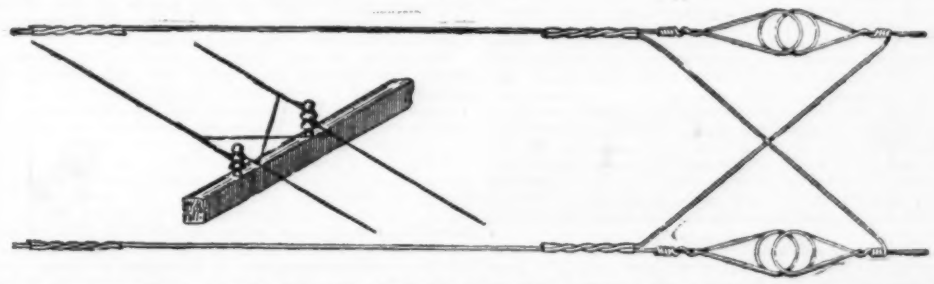


FIG. 2.—METHOD OF TRANSPOSING WIRES ON THE NEW YORK-CHICAGO TELEPHONE LINE.

The present line carries two cross-arms, which will eventually carry 10 wires each. The line passes through or is connected by short branches and loops with the most important cities between New York and Chicago.

Credit must be accorded to the enterprise and management which has made the New York-Chicago line a possibility, but we cannot close this description without a brief mention of those who have had immediate charge of the work and have brought it to a successful completion. Mr. E. P. Meany, assistant general manager of the Long Distance Company, has had charge of the construction work of the entire line, and F. A. Pickernell, engineer of the company, has had general charge of the electrical and mechanical working out of the system; while Mr. A. S. Hibbard, the general superintendent, has had charge of its operation and maintenance. The company is to be congratulated on the possession of the services of men so thoroughly competent, and whose work will, no doubt, prove of permanent value to the profession at large.—*Electrical Engineer.*

"BREADTH" IN PHOTOGRAPHS.

THOUSANDS of amateurs have taken up, and will take up, photography as a pastime who have never had any training in drawing or painting in oil or water colors, and therefore have had no chance of becoming acquainted with terms used in art and their meanings, and it naturally follows that they cannot apply these principles to their work in the form of study of composition, light and shade, and breadth of treatment, and it is mainly here that others who have enjoyed such opportunities, and have been draughtsmen or painters *before they took up photography*, step into the front ranks, and show superiority in their photographic work, and the best thing those who desire to excel can do is to take a term of training in any of the numerous schools of art now existent in every town of any size, and so qualify themselves *to see* in nature *with educated eyes* things they now look at with a pleasing, but at the same time artistically uneducated, effect.

If I were asked to define in as few words as possible the meaning of "breadth" in a picture or photograph, I should be disposed to say that it is the *absence of spottiness*, or the reverse of the effect of spottiness, and that abundance or minuteness of detail in the picture or print has nothing whatever to do with it either one way or another, provided that detail (though microscopically sharp) *is kept in subordination to the general tone of the parts of the picture or print where it exists.*

"Breadth" is a quality of great convenience to the painter; it enables him *to ignore* the wealth of detail which would cost him infinite time and labor to produce with brush or pencil, and which, if produced, would distract the interest of the spectator and attract attention, to the detriment of the principal "motive" of the picture. Therefore he subordinates detail, or, if painted in, he "glazes" it over and tones it down with some transparent pigment which, while it prevents undue attraction to the eye, permits it still to be found by any one who *seeks for it.*

Breadth is so essentially an *artistically created* quality that it is not frequently seen in nature, except under special conditions of light and shade. This is sufficiently evidenced by photography itself, from the fact that so few photographs possess it. If any one desires to study the effect of "breadth" in natural landscape, they must be on the watch for it soon after sunrise on summer mornings, or in the late afternoon and evening, when the sun is at a comparatively low altitude, and how few photographers ever attempt to get their negatives taken at such times. Wait till the sun reaches an altitude of sixty-five or seventy degrees, and it becomes very difficult to find "broad" effects of lighting, because every object becomes so generally illuminated that "spottiness" in the lighting is universal, and it is only by selection of larger masses of shadowed subject that "breadth" can be obtained.

Again after a shower of rain, when every atom of foliage sparkles in the light with wet reflecting surfaces, the quality of breadth is absolutely impossible to secure, and such a subject may be taken to express a quality the very opposite of "breadth." The moral is: Don't take any negatives under such disadvantageous circumstances, however beautiful the view may appear to your senses; the result in the photograph must be general spottiness, distraction to the sight, and vexation to the perception of artistic friends.

How, then, is "breadth" to be secured in our photographs? In two ways—partly photographic and partly artistic. First, by careful study of the time of day, early or late, when the subject is broadly lit, and taking negatives at such times. Second, by imitating the work of the artist and toning down in the finished print such obtrusive spotty lights as tend to destroy the breadth of the picture, and which have been found impossible to avoid in the natural view.

The followers of the fuzzy definition school had the attainment of this quality of breadth very strongly in view in adopting the "out-of-sharp-focus" principle, but it appears to me that it is a mistake to suppose that it can be attained by that means. The broken effect of spotty lights among broad shadows is just as apparent, though not so strongly accentuated, when they are thrown out of focus, and the distracting effect is the same, and, therefore, nothing is gained by diffusion of focus; but if these disturbing lights, which *will* come where they are not wanted, can be toned down so as not to be obtrusive, the effect of breadth can be secured *without the sacrifice of good definition*, which has such a charm in photographs when well managed, and which artists enjoy as much as any one else when kept down in proper subordination to the general tone and lighting of the picture.

Another method of securing breadth to a large extent is by giving *full exposures*. We all know that the consequence of under-exposure is great contrast of light and shade, and the more the negative is forced to bring up latent detail in shadows, the more accentuated becomes the contrast and the spottiness. The reverse is the case with over-exposure, as the proper balance of contrasts is overdone, and general flatness is the result, which constitutes an exaggerated and spurious kind of breadth. Those who delight in so-called "brilliant" and "sparkling" negatives, and aim at sufficiently short exposures to secure them, often err by obtaining negatives deficient in the quality of breadth by reason of this very "sparkle" and "brilliance," and it is just the *critical point in correct exposure* to obtain the true effect of breadth without either spottiness on one side or flatness on the other, and it is only to be got by *sufficiently full* exposure and restraint in development. This will secure it photographically, but, allowing for accidents in timing the exposure, or *impossibilities in obtaining perfect natural lighting*, it is as legitimate to adopt the artist's method, and to tone down objectionable lights in the print, as it is for him to "glaze" or "scumble" his effects on his canvas, and, as a final resort, is often the only way to obtain the desired effect of breadth.—"*Lux*," *in Br. Jour.*

SILVERING GLASS MIRRORS.

SOME years ago I had occasion to silver several glass mirrors, and in doing this I followed a process given in the *Chemical News* for March, 1869. I was inexperienced at that time in all kinds of chemical manipulations, and although the mirrors were not large, the success which attended my work was such as to lead me to receive the statement of the article in the December number of *Astronomy and Astro-Physics* "that hard and fast rules cannot be laid down" with some qualifications.

The process which I employed was given in the *Chemical News* as "Mr. Browning's process." I presume that the directions, as I have them now, were not copied verbatim, but they have all essential points. I worked at any convenient temperature without experiencing difficulty. I give the directions below.

Prepare three standard solutions: (A) Crystals $AgNO_3$, 90 gr., H_2O, 4 oz. (B) Potassa, pure by alcohol, 1 oz., H_2O, 25 oz. (C) Milk sugar powder, ½ oz. H_2O, 5 oz. This (C) must be prepared fresh at time of using.

Pour 2 oz. solution (A) into a vessel holding 35 oz. Add ammonia, stirring constantly till a clear solution of the precipitate first thrown down is obtained. Add 4 oz. solution (B). Add ammonia just sufficient to redissolve precipitate. Add water till the bulk reaches 15 oz. Add drop by drop solution (A) till a gray precipitate is formed which does not dissolve after three minutes' stirring. Add 15 ounces more distilled water. Let it settle. Do not filter. When the mirror is ready, add 2 oz. solution (C) and stir thoroughly. (Solution (C) may be filtered.)

Cement pieces of cork to the back of the mirror as handles. Pour on the surface strong nitric acid and rub it all over with a brush made by plugging a glass tube with pure cotton wool. Clean thus thoroughly the surface and edges, wash well with common water, and then with distilled water, and then lay face downward in spirits of wine (strong) till silvering fluid is ready.

Immerse the mirror face down in solution, so that it may rise about one-eighth of an inch on the edges, avoiding bubbles beneath. Let it remain an hour or two. Then wash immediately with a large quantity of water, then with distilled water. Place on edge on absorbent paper to drain and dry. Polish with gentle rubbing with softest wash leather. Finish with same dusted with thoroughly dried rouge obtained by stirring rouge in water, pouring off what does not settle in fifteen minutes, and collecting in filter.

My principal difficulty was in cleansing the mirror. I found it advantageous to use strong nitric acid, strong ammonia, and water in succession several times, ending with distilled water, and immersion in alcohol. The difficulty in this was a resulting elevation of temperature requiring that the water be not cold, or the changes of temperature loosened the cemented handles. Obviously heavy mirrors would require special precautions and widely different methods of support.

A very little tartrate of copper proved a desirable addition to the silver solution. I have no record of the proportion added, but it was very little.—*Chas. H. Chandler; Astronomy and Astro-Physics.*

CHEAP CARRIAGES.

WE hear a great deal said about the making of cheap carriages in Amesbury, and sometimes hear predictions of wonderful success to the firm that engages in this special work.

To make an article of manufacture at low cost there are a number of essential requirements, among which are, large capital, duplication of work, or the making of similar parts by the thousand; for we well know that the doing of one thing by a workman continuously makes him an expert, and able to produce a greater amount in the same time than if his work were diversified.

With all these advantages the profit is not as large as one might imagine. But, as we have said, if a large capital is behind the firm and an extensive business done, the aggregate counts up.

If 500 carriages are made per year at $1 profit on each, it is very evident that there would be more money for the manufacturer to don his overalls and hire out to some manufacturer of higher priced work; but if, instead of 500 carriages, the product amounted to 5,000, the dollar apiece profit would make a good income of $5,000. This scale of profit is, of course, taken for convenience, as actually it is very much larger.

The methods of manufacture would have to be altogether different from those now pursued, and the details carefully considered.

For instance, many of the connections would be cast and their cost reduced, and in a thousand and one ways the expenses reduced.

Undoubtedly many of our younger readers and workmen, and perhaps some of the dealers, think that right here in Amesbury they could commence the manufacture of a cheaper grade of work and thereby coin money. But to them let us say that it has been tried, and the manufacturers have arrived at the conclusion, long ago, that it doesn't pay, and that their only salvation is to make good work, and apply themselves to the production of novelties, which is a far better paying business.

Let us take the making of a popular carriage, an open buggy or road wagon, as an instance of the making of low priced carriages without the duplication processes.

In the first place the body will cost about $5. This is a pretty good body, one of the best, perhaps. The gear wood, shafts, axle beds, perches, head block and side bars will cost $3.50, but can be bought for $2.25.

The steel axles can be bought for about $1.85; the circle for 35 cts.; shackles and shaft couplings for 65 cts.; springs, from $1.85 up; labor, $4 or $5; wheels, from $4.50 to $7, unironed. The ironing will cost, say about 75 cts. for the tires, and for labor and boxes $2.50. The expense of painting could probably be kept down to $7. For trimming, the cheapest cloth would cost $2.10; and 12 ft. of leather for dash, shaft coverings, etc., $1.20. The hair would cost, say 60 cts., and the carpeting $1.20. Two yards of rubber cloth for boot would cost 50 cts., but an imitation can be bought for 15 cts. per yard. Two yards of wadding would cost 30 cts.; three pounds of excelsior, 6 cts.; tacks, buttons, etc., 25 cts.; whip socket, 15 cts.; straw board, 5 cts.; marlin for seams, 5 cts.; shaft straps, tips, etc., 50 cts. The labor would be about $3, or, by the 100, about $2.50.

If we remember aright, the freight on a carriage to Boston from Amesbury is $2.50, and to this 50 cts. for cartage across the city makes $3.

To summarize, the wood work costs $7.25, but we will say $7; the iron work, about $13.75; painting, $7, although $8 would be better; trimming, about $9.25—a total of $38.

To this add interest on capital, insurance, taxes, and any other expenses, and we fail to see where a great amount of profit is made.—*Amesbury Vehicle.*

GAS VS. ELECTRICITY FOR ILLUMINATING PURPOSES.

AT a recent meeting of the Civil and Mechanical Engineers' Society a paper on the above-named subject was presented by Mr. S. a'Court, Assoc. M. Inst. C. E.; and, in his absence, it was read by the honorary secretary (Mr. E. H. G. Brewster, Assoc. M. Inst. C. E.)

The author commenced by stating that, in choosing the subject of his paper, he had been to a great extent influenced by an article which recently appeared in the *Journal of Gas Lighting*, in which, to his mind, the matter had not been fairly considered. He had therefore collected information on the rival illuminants, and had done his best to set before the society the merits and demerits of each. He then passed on to the subject of the production of the two lighting agents. With regard to gas, he remarked that recent strikes and the scarcity of cannel prevented managers from having those peaceful nights which they formerly enjoyed; while experiments with water gas and enrichers were costing many tens, if not hundreds, of thousands of pounds, with, as yet, no published record of success. Electricity depended upon power plant only; and steam could be raised very well from any oil or non-illuminating gas. Therefore, as far as the future is concerned, one need never be afraid of being able to keep dynamos running. Dealing next with the public lighting of the streets and squares of London, the author referred to the fact that no two parishes are alike in the quantity of light per unit area of streets of equal size, nor do they agree in the actual positions of the lamps. In St. Pancras the arc lamps are on posts in the center of the main thoroughfares; while Westminster is content with gas lamps in the middle of the roads and along the edges of the pavements. He thought it would be admitted that the tendency of the age is toward better public lighting. He acknowledged that gas lamps have lately been much improved in respect of their light-giving power; and the reflectors fitted to the street lanterns distribute the light well. The three and five burner lights in Westminster consume 30 and 50 cubic feet per hour respectively, which, at three candles per cubic foot, means 90 and 150 candle power. The author had not been able to discover any proof of the makers' claim of 279 candle power, or 5·4 candles per cubic foot, for the 50-feet burners. Arc lamps burning with 10 amperes and 45 volts had been tested photometrically and found to give 1,500 candle power at 45°. What was really required was a good and well distributed light at a low cost to the ratepayers.

Passing on to deal with the practical question of street illumination, the author said all lighting engineers owed a deep debt of gratitude to Mr. A. P. Trotter, for his experiments on the distribution of light in our streets. The results obtained by him with his portable photometer prove how irregular street lighting is. These show that while, for small streets, gas lamps of 12 candle power, with those of 90 candle power at crossings and refuges, will give sufficient light, yet, when important streets are taken, the number of high power gas lamps required to give proper illumination means a large initial outlay and a heavy bill for running expenses. A 10 ampere arc lamp complete, with post and lantern, costs £18 10s.; a 50-feet gas lamp complete, with post and lantern, costs £14 11s. The contract price per arc lamp per annum for current, cleaning, carbons and repairs in London and other towns is £26 on the all-night schedule. A 50-feet gas burner on the all-night schedule, with gas at 2s. 2d. per 1,000 cubic feet, will cost £23 8s. for gas alone, or £25 per lamp per annum with cleaning, etc. This is paying the same price for practically one-tenth of the light. It is true, however, says Mr. a'Court, that, excepting where we have arc lamps in the center of the roadway, a great portion of light is more or less wasted on the side of the lamp toward the houses bordering the streets; and therefore, to compare the two lights, allowance has to be made for waste. It has been found that, to secure good lighting, there are required on both sides of the street 10-ampere arc lamps, placed at a height of 25 feet, and at a distance not exceeding 150 feet apart, measured from lamp to lamp on the same side. When streets are more than 50 feet in width it is necessary to re-enforce the lighting with arc lamps on central refuges. In order to give an equal lighting effect with gas, it is found that high power lamps have to be placed in groups of three on refuges, and erected about 50 feet apart along the sides of the even 40-feet streets. The distribution of high-power gas lamps is so different from that given by that of an arc lamp, that it is difficult to fix any exact ratio for equal lighting effect; but, roughly speaking, yet making every allowance for gas, five 50-feet gas burners are required as against every 10-ampere arc lamp. On this basis the first cost of each, for equal lighting effect, works out to electricity 1 to gas 3·9; and running expenses, 1 to 4·8. It is therefore clear, according to the author, that, for the proper illumination of main streets, there is no comparison in either first cost or annual expense. The electric light is enormously cheaper.

In small streets, where lamps serve only as buoys to mark out the channel, gas is cheaper than incandescent electric lamps of equal power (12 candle). But before long we shall be wanting better illumination of small streets; and then it may be found that, if the power of the lamp is raised to 50 candles, electricity can compete, and that favorably. As in London we are, unfortunately, only too familiar with fogs, and those of the deepest dye, the author has had ample opportunities of studying the effects of the rival illuminants under such conditions.

On one occasion last November, going along Piccadilly at 10 o'clock at night, in a dense fog, it was impossible to see any other lamplight whatever when standing on the curbstone under a gas lamp, while, during the same fog, it was possible to steer in Parliament Street or Victoria Street—proving that the illumination in those two streets was rightly adjusted to the maximum requirements.

After briefly alluding to railway station lighting, where, the author says, arc lamps appear to have practically superseded gas, he proceeded as follows: It is when we come to domestic lighting that the greatest difference [in the two lights] is apparent. Arc lamps are unsuitable except for shops or large offices; and electric glow lamps or gas burners have to be used. The gross revenue derived from each 8-candle power glow lamp connected to a supply company's mains in London varies from 18s. 6d. down to 7s. 6d.; but it is found that 10s. per lamp is the average for private houses.

The revenue for gas lamps of 8-candle power—*i. e.*, the ordinary 4-feet Bray burner—comes to about 10s. This has been calculated from Mr. Newbigging's "Handbook:" gas being taken at 2s. 4d. per 1,000 cubic feet. Renewals, supposing ordinary gas burners to be used, come much higher for electricity; but if the Welsbach or any other regenerative or Argand burner is used, the difference is not so great, if we include cleaning and the renewal of mantles and glasses and take into consideration interest on first cost. With ordinary care, an 8-candle electric glow lamp will last about two years without renewal, or, say, 1,200 hours—giving throughout an average light of 7 candles, the depreciation being due to blackening of the interior of the globe. A No. 4 Bray burner, when clean and new, with 16-candle gas and 1·5 in. pressure, will give 12 candles, and last about the same time as an economical burner.

The author summed up as follows the chief differences between gas and electricity, putting the *pros* and *cons* side by side:

Gas.	*Electricity.*
Costs one-third less for equal light.	Costs more for burning.
Equal cost to install in old or new house.	
A leak is dangerous— (1) To health. (2) May cause fire. (3) May cause explosion, generally followed by fire.	A leak— May cause fire.
Heats and vitiates the air.	Heats the air slightly.
When vitiated the light is depreciated.*	Not affected.
Matches required for lighting.	Turn a switch.
Not good for decoration.	Adapts itself to any decoration.
Steady light when not burnt in a draught.	Steady light under all conditions.
Most convenient for cooking and heating, though very expensive.	Not yet practically employed for either.
Must be laid so as to avoid any siphon, and is badly affected by frost.	Conductors can be laid in any way, up or down, and frost has no effect.

He admitted that the ordinary Bray gas burner is cheaper than an electric glow lamp for equal candle power, as regards the actual cost of gas or current, but he pointed out that a paraffin lamp is much cheaper than gas. It was inaccurate to state that the steady annual increase in the quantity of gas sold was because of its cheapness. The reason was that electricity had shown people what a good light really means, and consequently our streets and houses are better lighted, and therefore we now have the enormous increase of high power public gas lamps.

The subjects of the regulation of supply and pressure were next considered. There was one point, the author remarked, which was not sufficiently appreciated, and that was the apparent incapability of gas companies to supply gas at equal pressure all over their districts, much less to keep the pressure constant at any point. The gas acts were a useful piece of legislation; but they required a supplementary Board of Trade order to enforce supply at constant pressure. Under the electric lighting acts, electricity must be supplied with a maximum variation of 2 per cent. either way. The author said he had been unable to find any information as to the alteration in luminosity due to this 2 per cent. variation in glow lamps of different power; nor had he been able to discover much about the effect of varying pressures on gas burners, except the test made by Dr. Wallace in 1880, which showed that, at the time of greatest load, the ordinary small consumer, with no patent regulator, had 15 per cent. less light, and paid 100 per cent. more for it. He recently recorded a difference of nearly 100 per cent. in the pressure in Westminster in one hour's time; and in the City a variation of 24-10ths to 30-10ths in half an hour. He admitted that regulators are largely used; but he thought it was not fair that they should have to be provided by the consumers; and, so far as he had found, these appliances were not perfect. As to the quality of the two illuminants, gas only could, and did, vary, notwithstanding

* With 0·26 per cent. of carbon dioxide, to the extent of 5·7 per cent.; with 0·60 per cent., to 20 per cent.; with 1·26 per cent. to 100 per cent. or no light.

inspection. This was another point in favor of electricity, which could only be of one quality.

The last subject to be discussed was measurement. The author quoted the well worn phrase to "lie like a gas meter," which he said was unhappily borne out by facts. He had occasion recently to examine the tests of 400 gas meters of all sizes, taken as they came in for testing or repairs; and he found the greatest errors were 16·63 per cent. fast and 10 per cent. slow—the total against the consumer averaging 0·5 per cent. Electricity meters were comparatively new inventions, and were by no means perfect. As an instance of the way in which the electric supply companies appreciate this matter, the author mentioned that one of the largest companies in London never leave a meter on a consumer's premises longer than 18 months without replacing it with a newly tested one; while all meters, as they come in for testing, are entirely taken to pieces and cleaned before being retested and again sent out. He thought if gas companies did the same, less trouble would be heard of. The Board of Trade had, up to now, refused to accept any type of electricity meter as exactly complying with their requirements; and if an ancient gentleman were to be seen wandering about the world with a lantern in his hand, we should at once be able to "spot" him as a Board of Trade philosopher following the example of Diogenes, and searching hopelessly for an honest meter, whether gas or electric.

In conclusion, the author expressed the opinion that electricity has a great and near future in providing the best form of illuminating agent; while gas will always be of great service for heating, cooking, and motive power. In fact, he thought that at no very distant date we might find gas companies supplying non-illuminating gas only, for heating and cooking, which would to a great extent do away with the yellow of a London fog; and the gas, if supplied, as it probably could be, at 4d. per 1,000 cubic feet, could be burnt under the boilers of the electric supply companies, and produce cheap electric light and power.

THE MANUFACTURE OF LIQUORS AND PRESERVES.*

By J. DE BREVANS, Chief Chemist of the Municipal Laboratory of Paris.

PART II.—CHAPTER VII.

Medicinal Wines.

THE following aperitives and cordials follow the *Codex*.

Absinthe.
Vin d'absinthe.

Dry leaves of absinthe	30 grm.
Alcohol (60°)	60 grm.
White wine	1000 grm.

Cut the absinthe and put in immediate contact with the alcohol in a closed vessel, after twenty-four hours draw off, add the wine, allow it to macerate for ten days, and agitate from time to time. Press and filter. This is a bitter wine, and is tonic and stomachic.

Coca.
Vin de coca.

Leaves of coca	60 grm.
Wine	1000 grm.

Crush the leaves and macerate in a closed vessel for ten days in wine, agitating from time to time. Press and filter.

The wines of colombo, eucalyptus and bitter quassia are prepared as follows:

Material	30 grm.
Wine	1000 grm.

Reduce the root or other material to a coarse powder; macerate in a closed vessel with the wine for six days, agitating from time to time. Press and filter.

Gentian.

The gentian (Fig. 51) grows to about one meter in

FIG. 51.—GENTIAN.

height. Large root, large wrinkled leaf, bitter taste, flowers yellow or yellowish red.

Gentian Wine.
Vin de gentiane.

Gentian root, cut fine	30 grm.
Alcohol (60°)	60 grm.
Red wine	1000 grm.

Place the root in the alcohol in a closed vessel and after twenty-four hours add the wine, macerate for ten days and agitate from time to time. Press and filter. Gentian wine loses its color, so that it should be prepared as wanted.

* Continued from page 14284, SUPPLEMENT No. 894.

Quinquina (Quinine).
Vin de quinquina gris.

Quinquina, gray officinal	50 grm.
Alcohol (60°)	100 grm.
Red wine	1000 grm.

Reduce the quinquina to a coarse powder, leave it in contact with alcohol for 24 hours in a closed vessel, add the wine, macerate for ten days and agitate from time to time. Press and filter.

In the same manner are prepared the yellow and the red wine of quinquina, but in making them take 25 grm. of quinquina for the same quantity of alcohol and wine. White wine may be substituted for the red wine.

CHAPTER VIII.

Punches.

Under this name are included mixtures composed of an infusion of tea, lemon juice, brandy, rum, etc.

Rum Punch.
Punch au rhum.

Prepare an infusion of 10 to 15 grm. of good hyson tea with a half liter of boiling water. Cut up half a lemon and place it at the bottom of a deep vessel, add 200 to 250 grm. of fine sugar and throw on the hot tea. Add one-half liter of old rum carefully, so that it does not

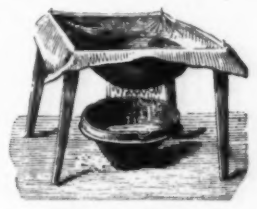


FIG. 52.—FILTERING BAG.

mix with the infusion of tea. In a few seconds the rum becomes heated, takes fire and is allowed to burn until it goes out, then mix thoroughly and serve the punch.

Punch au kirsch.

This is prepared in the same manner as brandy or cognac punch.

CHAPTER IX.

The Clarification and the Preservation of Liquors.

SECTION I.—CLARIFICATION OF LIQUORS.

Limpidity is one of the principal points to be looked at in the manufacture of liquors. This is usually done either by a process called *collage* in French, the English word sizing coming nearly to the meaning, or by filtration.

Sizing.—Various substances serve to size liquors—albumen, white of an egg, fish glue, gelatine, milk, etc. For example, in sizing a hectoliter of liquor with white of egg, the operation is carried on in the following manner:

Take the whites of three eggs, beat in one l. of water, with sprigs of osier or a Dover egg beater, throw into the liquor and allow it to repose from 24 to 48 hours.

This method is largely used for those liquors which are milky, by reason of the minute globules of volatile oil or resinous substances which enter into the composition of the liquor. It can also be used for liquors prepared by infusion, but the quantity of white of egg is reduced to two-thirds.

Fish glue for clarification is used as follows: 10 grm. of fish glue are dissolved in a small quantity of white wine or water to which a little vinegar is added. Beat from time to time and add a little vinegar or white wine so as to reach 1 l. When dissolved, the fish glue is thrown into the liquor, which is beaten for ten minutes. Allow it to repose for several days. Fish glue answers admirably for those liquors which are very alcoholic.

Gelatine (30 grm.) is dissolved in 1 l. of water, which is heated. Add the solution to the liquor, strongly cork or bung it up and leave it to repose for

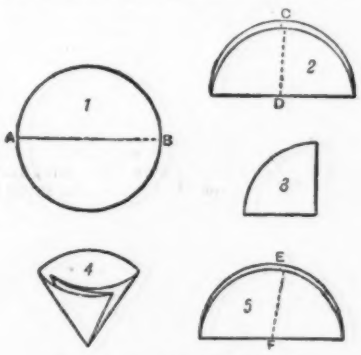


FIG. 53.—FILTER PAPER.

several days. The gelatine is used principally for white liquors and those weak in alcohol.

The liquors which contain little alcohol are treated with milk. A liter of milk is heated and poured while hot into the liquor. Stop up tightly and add 15 grm. of alum dissolved in a glass of water. Cover closely or bottle and allow it to repose for several days.

Filtration.—Filtration has for its end the removal by means of some substance which will allow only the liquid to penetrate, of particles of matter which are held in suspension. When only a fair amount of filtration is required, that is when the liquid need not be absolutely limpid, a blanket or filtering bag (Fig. 52) is used. To obtain perfectly clear liquor it is necessary to use unsized filter paper, which is usually either white or gray. In general liquor manufacturers employ round filters, which are folded as follows:

A circular filter paper is readily made to fit the funnel by folding it across one diameter as shown at A B in 1, Fig. 53, then on folding it again at right angles, as at C D in 2, it has the form of 3; now, on inserting the finger between the folds of the paper, it may be opened out to the conical shape shown in 4, and is thus ready to place in the funnel. If, however, the paper should not fit well into the cone of the latter, it may be refolded along the line, E F, as in 5, or along any other suitable line, and may thus be adapted to suit a funnel constructed with any angle at its apex.

If it be necessary to clear any solution which attacks paper, a plug of spun glass or of asbestos may be lightly rammed into the apex of the funnel, and will form an efficient filtering medium in lieu of paper.

The filter paper is placed in a glass funnel as illustrated in Fig. 54, which shows a pleated filter in po-

FIG. 54.—DOUBLE FUNNEL.

sition. Liquor manufacturers use large copper funnels. That made by the house of M. Egrot is shown in Fig. 55. It consists of two funnels and a reservoir for the liquor, all controlled by cocks. When large masses

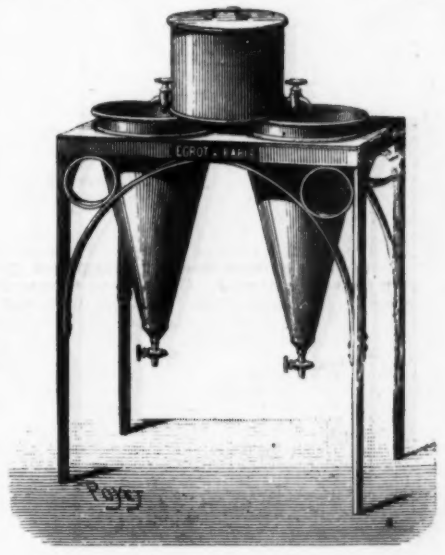


FIG. 55.—MOUNTED FILTERS WITH RESERVOIRS.

of liquid are to be treated, continuous filters or filter presses are used.

SECTION II.—PRESERVATION OF LIQUORS.

Preservation.—After filtration the liquor should be placed in dry casks and stored in a place which has a constant temperature, and away from the light.

Aging.—Age has the effect of mellowing liquors, by reason of the liquor becoming little by little more intimately mixed. The essential oils also becoming oxidized, this modifies the odor and renders it more agreeable. Aging can only be accomplished with time, and no attempt should be made to arrive artificially at this point.

Mellowing.—Liquor manufacturers use a device for imparting a mellowness to liquors which would ordinarily be only acquired with age. The liquor is heated in a water bath to 60°, a cooling pipe or an ordinary still being used. This temperature reached, the fire is put out and the still is allowed to cool down slowly. Liquors which are to be subjected to this operation must not be colored in advance.

(To be continued.)

WHAT CONSTITUTES GOOD VULCANIZED INDIA RUBBER?

AN investigation has recently been conducted by Lieut. L. Vladimiroff, at the St. Petersburg Technical Institute, with a view to establishing rules or tests whereby the quality of vulcanized India rubber may be efficiently judged. It is a notorious fact that no method of chemical analysis gives reliable results for this substance; hence the tests applied were chiefly of a physical nature. From a lengthy series of experiments, the following conclusions were deduced, namely: 1. India rubber should not give the least sign of superficial cracking when bent to an angle of 180° after five hours of exposure in a closed air bath to a temperature of 125° Centigrade. The test pieces should be six centimeters thick. 2. Rubber that does not contain more than half its weight of metallic oxides should stretch to five times its length without breaking. 3. Caoutchouc, free from all foreign matter except the sulphur used in vulcanizing it, should stretch at least

seven times its length before rupture. 4. The extension measured immediately after rupture has taken place should not exceed 12 per cent. of the original length of the test piece of rubber. The test piece should be from 3 to 12 millimeters long, 3 centimeters wide, and not more than 6 millimeters thick. 5. Softness may be determined by measuring the percentage of ash formed on incineration; it may form the basis for deciding between different grades of rubber for certain purposes. 6. The vulcanized rubber should not harden under the influence of cold temperature. These conclusions are to serve in the establishment of rules governing the introduction of vulcanized rubber into the Russian navy.

THE COMMON PHEASANT.

ORIGINALLY a native of Asia Minor, the common pheasant is a wonderful instance of the successful acclimitization of a foreign bird in the British Islands, and a most important inhabitant thereof has he become. Hundreds of thousands of pounds are invested in the preservation and multiplying of his species; no small portion of rural England is reserved for his residence; and up to a certain date his person is as sacred as that of a fox. After the 1st of October his importance increases, but thousands of sportsmen, armed with the latest and most quick-firing of breechloaders, accompanied by keepers and beaters innumerable, march for his destruction; they violate with their hobnailed boots and gaiters the coverts that have hitherto formed his sure sanctuary, and poor *Phaysianus colchicus* appears suddenly and simultaneously in every poulterer's shop in the United Kingdom.

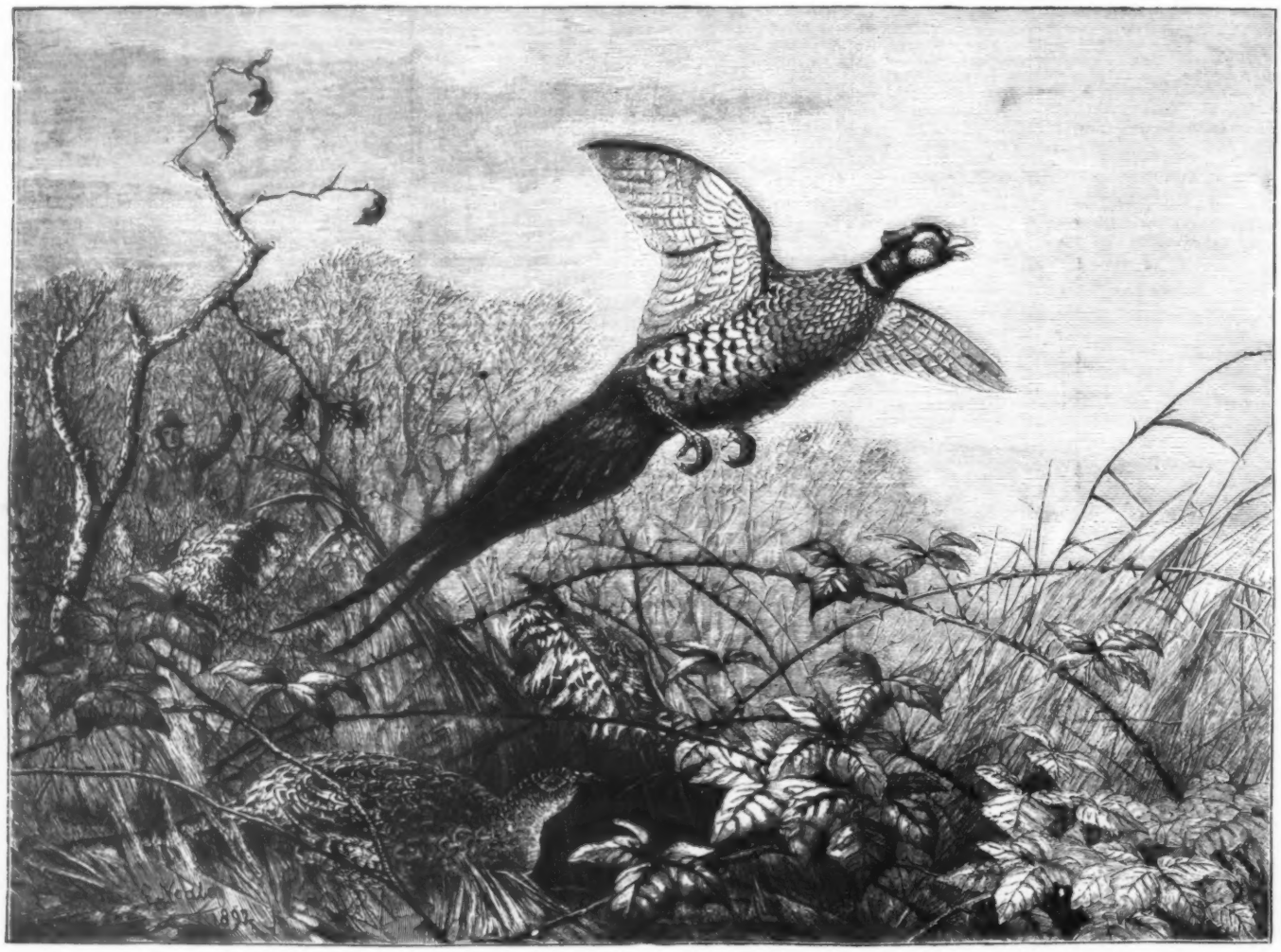
Some idea may be formed of the wonderful increase in the number of pheasants which has taken place in this country, from the figures given in the Badminton Library volume on shooting, as applying to some 10,000 acres of preserved land in Norfolk. On this estate, in 1825, the total bag was 89 pheasants to one gun; in 1860 it had increased progressively to 2,256; and in 1881 there were shot no fewer than 5,363 pheasants, the best day being 1,136 head to eight guns. Of course this enormous increase is due to artificial breeding and strict preserving—for the pheasant, especially in his early youth, requires much shelter and plenty of food; but it shows how much these may do when carefully carried out, materially benefiting the proprietor and the food supply of the community as well as the sportsman. The young birds are mostly fed upon ant eggs, maggots and grits, but when grown they eat seeds, roots and leaves indiscriminately. The cock is far from being a specimen of domestic virtue; he takes no notice of his offspring, and during the greater part of the year he leads a very independent kind of existence, associating mostly with others of his sex, while he frequently mates with the common hen, and sometimes with the grouse, turkey and guinea fowl. He is also of a very pugnacious disposition, and often enters into mortal combat with the barn-door cock, over whom he has no small advantage, owing to his powers of flight, which enable him, when fatigued, to ascend into a tree for recuperative purposes. Occasionally the hen pheasant chooses the deserted tree nest of an owl or squirrel wherein to lay her eggs, but her ordinary nest is a very rude construction, indeed, of leaves and grass, placed in a slight depression of the ground, with hardly any attempt at concealment; the eggs are of a uniform olive brown color, and usually from eight to ten in number.

The pheasant is an undoubted friend of the farmer, for he destroys vast numbers of injurious insects—a form of food which he loves beyond others—and over 1,200 wire worms, that worst pest of the farmer, have been taken out of the crop of a single bird. During the day he trusts more to his legs than his wings, but his habit of roosting among the trees makes him a conspicuous object and an easy prey to the poacher on moonlight nights. Our illustration represents the mode of procedure of these interesting but illegitimate sportsmen. The ingenious dodge devised by Mr. Waterton for the deception of these gentry and the preservation of his birds by having wooden pheasants nailed on to the boughs of his trees, is well known.

Among other varieties, the golden, silver and Reeve's pheasants have been also introduced, with more or less success, on some of the great sporting estates in England. The last named is, perhaps, the handsomest bird of his handsome race; the body no larger than that of the common pheasant, a cock in full plumage yet measures 8 feet from head to tip of the tail feathers, which are themselves six or seven feet in length, and beautifully marked. Reeve's pheasant, or, as it is called in France, *le faisan vénère*, will more readily take to wing than most of his kind, and although so splendid and highly colored, is a hardy bird, his home being among the snow-clad mountains of Surinagur and in Northern China.

Both the golden and the silver pheasants are also natives of the last-named country, in which the former especially is held in great esteem, not only for his elegance of form and splendid plumage, but also for his delicacy of flavor, which surpasses that of the common variety. It is hardly necessary to remark upon the value of the plumage of this gorgeous and very beautiful bird to the salmon fly-fisher, who greatly prizes his crest, neck and tail feathers more especially.

The silver pheasant is a much larger and more powerful bird, and, like his golden brother, has become an inhabitant of a good many British preserves; his weight, however, being out of proportion to his strength of wing, is rather against him, and he falls an easy victim to stoats, foxes and polecats.—*Black and White.*



THE COMMON PHEASANT.

CHURCH INCENSE.*

By J. C. MCWALTER.

CONSIDERING that incense is in constant use in at least 7,000 churches in the British empire, the question of its proper preparation has not, I imagine, received that attention which it deserves at the hands of practical pharmacists.

Perhaps the explanation of this is that but few chemists sell incense, and that fewer still are inclined to go to the trouble of making it themselves, as the sale is largely in the hands of chandlers and suppliers of church requisites. But it should be borne in mind that these latter never think of preparing it, and look to a druggist for their supply. Hence, although a chemist may have no direct communication with the consumer of the article, it does not follow that it is not worth his while to inquire into its nature.

According to Homer, the Egyptians of his time were undoubtedly a nation of druggists. In this characteristic, which they have maintained to the present day, and in many others, they resemble the Hindoos; and although they have changed their religion, the use of incense among them is as frequent and familiar as ever. From Meroe to Memphis the commonest subject painted or carved on the interior of the temples is the contemporary Pharaoh offering oblations and incense to his favorite deity.

Various substances were used in the preparation of this incense, but the commonest were probably myrrh, the mor of the Hebrews, and the gum resin of the Balsamodendron Myrrha, so well known to the craft, which it was usual to offer at midday; besides frankincense, the labonah of the Hebrews, the labonas of the Vulgate, and the gum olibanum of commerce. The kohl or black powder with which the modern, like the ancient, Egytian ladies beautify their languishing eyelids, is composed principally of the soot of charred frankincense, and this same gum, without any admixture, is, I understand, used chiefly as incense in Rome at the present day; in fact, the Latino-barbaric word olibanum (quasi oleum libani) is found in a bull of Pope Benedict IX. That olibanum was in use in the earlier days of the church is evidenced by Tertullian (A. D. 198), who says: "It is true we buy no frankincense, though the Arabians may complain of this;" and again, "I offer a rich sacrifice, not one pennyworth of the grains of frankincense." And St. Augustine, 396, says, "We go into Arabia to seek for frankincense, nor do we ransack the packs of the greedy traders."

But however venerable the antiquity which olibanum may claim, the use of it exclusively as incense is, I have found, not always satisfactory. The objections to it are that the better kind, which occurs in large white tears, melts and cakes on the thurible, that it gives off a terebinthous odor, more or less marked according to the sample, and finally that it does not produce a sufficient volume of smoke. Now, the commoner kind, which is known in common as gum olibanum parv., makes a better incense, as the proportion of oil is about 4 per cent. against 7 per cent. in the white tears, and the amount of woody matter adhering to the bark increases the quantity of smoke. When mixed with about 3 per cent. of powdered white resin and crushed, it may confidently be offered where price is a paramount consideration.

When an incense was required to retail at 2s. 6d. per pound, I have found a very satisfactory result from the usual formula of olibanum, benzoin, and cascarilla, taking two parts of benzoin, reduced to a coarse powder, with one part of coarsely powdered cascarilla bark, and seven parts of crushed gum olibanum parv., the whole mixed thoroughly together. A formula for an incense with essential oils is given in Cooley's work, and one with vitivert in Dr. Piesse's "Art of Perfumery;" but the odor of essential oils seems to be either greatly altered or destroyed when placed on the glowing charcoal, so that an in-

* *Brit. and Col. Druggist.*

cense which has a most fragrant smell in the tin produces quite a disappointing, if not irritating, effect when placed in the thurible. Rather a favorable example of the formula with essential oils is benzoin and storax, of each 4 oz.; olibanum and myrrh, of each 6 oz.; cascarilla, 3 oz.; oil of cinnamon, 8 drms.; oil of bergamot and lavender, of each 20 drops; and oil of clove, 10 minims.

The more fashionable churches are prepared to pay from 3s. 6d. to 7s. 6d. per pound for their incense, and the shops which supply them generally procure it from France. It is supplied in a much finer powder than the home-made incense, and appears to consist largely of aromatic woods; hence it emits a large quantity of smoke and a pleasant perfume, though it probably somewhat lacks that benign physiological effect which, according to Plutarch, fuming frankincense has on those offering it. The chief ingredients used in the Continental incense seem to be sandal wood, said to be the algum or almag wood of the Bible, cinnamon, sweet cane (Andropogon Calmus aromaticus), cascarilla, myrrh, and olibanum, with occasionally musk and charcoal, as well as a styrax.

Some time since I was asked by a manufacturer of church articles to let him have some of the best incense that could be procured, and made some investigations with a view of preparing an incense according to the biblical formula. That is found in Exodus xxx., 35, and is as follows: "Take unto thee sweet spices, stacte, and onycha and galbanum; sweet spices with pure frankincense, of each shall there be a like weight; and thou shalt make of it incense, a perfume of the art of the perfumer, seasoned with salt." The difficulty with this formula is the recognition of the articles mentioned. Some commentators say that the term sweet scents (sammin) referred to the four ingredients mentioned above, and others seem to think that the sweet scents were seven other ingredients which the Jewish doctors affirm were communicated to Moses on Mount Sinai; namely, of myrrh, cassia, spikenard, and saffron, of each 16 parts, of costus (Aucklandia costus) 12 parts, cinnamon, 9 parts, sweet bark, 3 parts. It is decidedly more convenient, however, to suppose that the four ingredients were the sweet spices. Now, of these we know frankincense, and we know galbanum (Heb. nataf.) is generally referred to the storax officinale of the Levant, or, according to Hanbury, the Liquidamber orientale. Onycha is, according to some, the celebrated odoriferous shell of the ancients, the operculum of the Blatta Byzantina. Other shold that it is the bdellium of Arabia, and merely something shining like a nail—perhaps the finest benzoin. The expression seasoned with salt has been, I should imagine, a source of trouble to many a pharmacist who wished to follow the directions, but who could not conceive the utility of salt as a perfume. It would appear, however, that although the Hebrew word literally means salted, it may be translated "tempered together." Hence the formula would be simple enough.

Storax (reed),
Benzoin,
Galbanum (sweetest savor),
Best olibanum, equal parts.

Mixed together and reduced to a fine powder to make biblical incense.

CICUTA MACULATA, LINNE.

By AUGUSTUS S. BLACKMAN, Ph.G.

Contribution from the Chemical Laboratory of the Philadelphia College of Pharmacy. No. 119.

THIS plant is known under the common names of water hemlock, spotted cowbane, beaver poison, etc. It is found throughout eastern United States, and flowers during July and August. The stem dies down after fruiting, but a bud and new tuberous roots are formed from a lateral branch, and a new stalk rises from these the following spring.

The root is oblong, fleshy, of a brownish color, with from three to eight thick, fleshy branches which grow in an oblique or horizontal direction. The interior of the root is yellowish white, and contains many cavities, which are probably formed by absorption of the tissue. This is an important characteristic, and is best seen in longitudinal section.

The odor is aromatic, resembling that of parsnip.

The taste is aromatic and sweetish, with an acrid after taste. On cutting a cross section of the fresh root a yellowish, resinous liquid is observed issuing from a zone of resin cells.

A number of cases of poisoning have at various times been reported, due, no doubt, to this root having been mistaken for that of the parsnip or of sweet cicely.

For the following investigation a quantity of the roots of cicuta was collected in July and allowed to dry, and about three months afterward a portion of the finely powdered drug was submitted to analysis, with the following results:

Solvent Used.	Substance Obtained.		Per cent.
Petroleum ether	Volatile oil	0·068	
	Fat	0·540	
	Wax	0·376	
			0·984
Stronger ether	Brown resin		1·380
Absolute alcohol	Resin		1·906
Distilled water	Mucilage	1·000	
	Dextrin	1·500	
	Glucose	3·555	
	Extractive	2·445	
			8·500
Dilute solution of sodium hydrate	Pectin	1·500	
	Extractive	1·000	
			2·500
Dilute hydrochloric acid	Pararabin		2·900
Boiling distilled water	Starch	5·500	
	Extractive	2·500	
			8·000
Chlorine water	Lignin		2·396
Nitric acid and potassium chlorate	Incrusting matter, Cellulose, Ash, Moisture, Loss		10·264 31·436 11·608 9·127 8·909
	Total		100·000

The fat obtained by petroleum ether melted at 57° C. and the wax melted at 96° C.

Tests for alkaloids and glucosides in the ethereal and alcoholic extracts failed to indicate them.

A portion of the original drug was then distilled with milk of lime; the resulting distillate gave negative indications of a volatile alkaloid. A number of other tests were then applied to the original drug for alkaloids, but with negative results.

Some of the green root freshly gathered was then obtained, and tested by extracting with acid, rendering this acidulated solution alkaline, and agitating with ether; this ethereal solution on evaporation to dryness yielded a residue, which when dissolved in acidulated water gave alkaloidal indications with a number of reagents. The green drug, however, when distilled with milk of lime did not yield any indications of a volatile alkaloid.

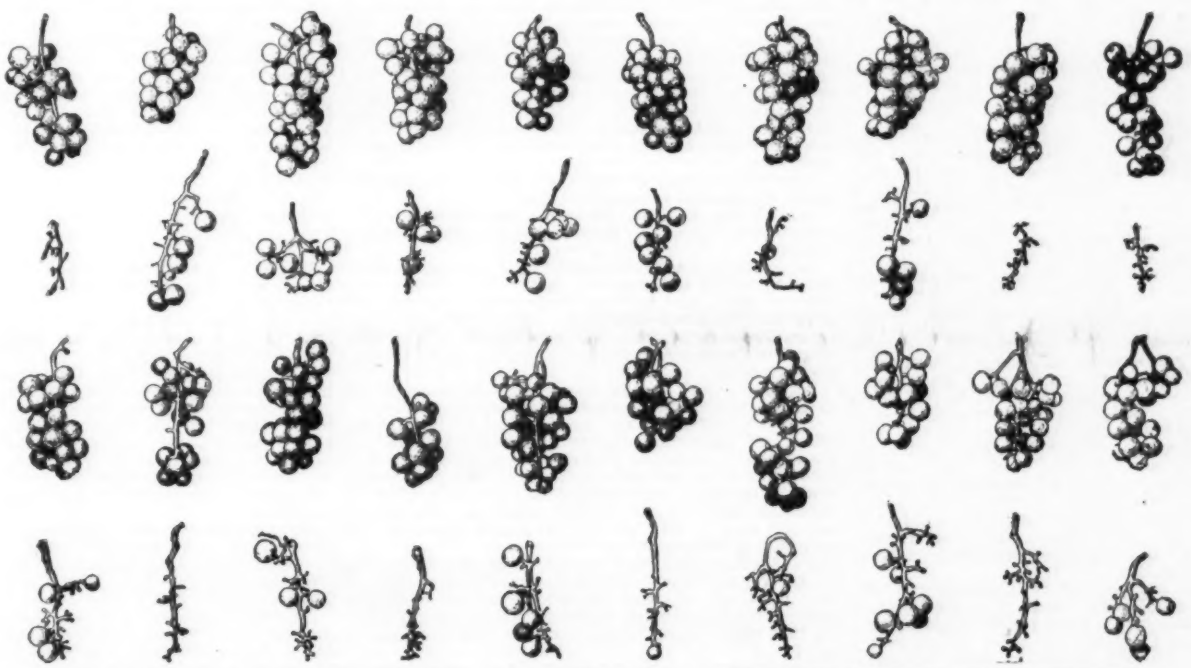
Some physiological experiments were made on a full grown healthy cat.

The dried drug used in the analysis failed to produce any unnatural symptoms when administered in 5 gramme doses. The green root, however, in 2 gramme doses produced great uneasiness, followed by vomiting.

The conclusions reached by this investigation are that there is probably a non-volatile alkaloid present in cicuta, and that it is either not present in the root in July or else it is decomposed by drying. The evidences of alkaloid were obtained from the root collected in November.—*Am. Jour. Phar.*

BLACK ROT OF THE GRAPE AND HOW TO TREAT IT.

YEAR after year grape growers all over the eastern United States suffer from the ravages of a disease known as black rot. This first attacks the leaves and appears as roundish, well-defined, brown spots, which as they increase in size run together and form large, irregularly shaped blotches, while numerous black specks are scattered over the surface. This injury seriously impairs the vitality of the plant, but it might be overlooked were these the only parts attacked. Unfortunately, when the berry is well formed it is frequently observed that a small brownish spot appears on one side. This gradually spreads and eventually involves the whole berry, which becomes withered, turns black and dries up. The whole cluster frequently becomes dried in this way. The general features are well shown in the cut given herewith.



BLACK ROT OF THE GRAPE; TREATED AND UNTREATED. BORDEAUX MIXTURE, HALF STRENGTH.

A series of investigations, carried on both by private individuals in this country and in Europe as well as by our government, have shown that the disease is caused by a species of fungus, the spores of which find lodgment on the leaves and fruit and in growth produce the effects noted above. The losses from the disease amount in the aggregate to a very large sum, and as a consequence an endeavor has been made to ascertain some method to prevent or to mitigate the disease. An accidental discovery in France showing the power of copper compounds to destroy fungi led to their use for prevention of black rot, with the most wonderful results. This is not a new discovery and it has been written upon until worn nearly threadbare, and yet there are thousands of farmers and small fruit growers who suffer the disease to destroy their grapes, when a slight expenditure of time and money would reward them amply.

The remedy that has so far been found to give the best results is known as Bordeaux mixture. Its strength has been very materially modified since it first began to be used, and the generally accepted formula, known as the reduced or half strength Bordeaux, is as follows: Copper sulphate 6 pounds, fresh unslaked lime 4 pounds, water 45 gallons. The preparation has been often described, but at the risk of repetition it is given again.

"In a barrel that will hold 45 gallons dissolve 6 pounds of copper sulphate, using 8 or 10 gallons of water or as much as may be necessary for the purpose. In a tub or half barrel slake four pounds of fresh lime. When completely slaked add enough water to make a creamy whitewash. Pour this slowly into the barrel containing the copper sulphate solution, using a coarse gunny sack stretched over the head of the barrel for a strainer. Finally fill the barrel with water, stir thoroughly, and the mixture is ready for use. Prepared in this way the cost of 1 gallon of the mixture will not exceed 1 cent, the price of copper sulphate being 7 cents per pound and lime 30 cents per bushel. In all cases it is desirable to use powdered copper sulphate, as it costs but little more and dissolves much more readily. It is highly important also that fresh lime be used."*

The first spraying should be made when the buds begin to swell, a second when the leaves are about one-half grown, and a third when the vines are in full bloom. Applications should be continued at intervals of ten or twelve days thereafter, until the first signs of ripening appear. In case of dry weather the sprayings should cease. The cost of the treatment is estimated at about $10 per acre.

No better proof of the efficacy of the treatment is needed than a glance at the plates given in Bulletin No. 3 of the Division of Vegetable Pathology of the Department of Agriculture, one of which is reproduced here. It is scarcely necessary to say that the first and third lines show grapes from treated vines, and the second and fourth lines those from untreated vines. With an object lesson such as this before him, he who any longer doubts the good results of treating vines for this disease must be obtuse indeed.

A substantial indication as to the value of spraying is given in the last pages of this Bulletin. In response to a circular sent out by the department for information relative to losses from grape diseases, about 2,500 replies were received. These showed that about 65 per cent. of the losses were due to black rot. Only about 250 grape growers replied to the questions in such a manner as to permit any definite results being obtained. But these reported an aggregate profit over all expenses of over $30,700, or nearly $123 each as a result of their work. This does not, of course, represent the total amount saved by grape growers who used Bordeaux mixture for rot, as this probably amounted to several hundred thousand dollars.

JOSEPH F. JAMES.

IT has been calculated that the electromotive force of a bolt of lightning is about 3,500,000 volts, the current about 14,000,000 amperes, and the time to be about 1-20,000 part of a second. In such a bolt there is an energy of 2,450,000,000 watts, or 3,284,182 h. p.

* Spraying for Insect Pests and Fungous Diseases. Farmers' Bulletin, No. 7, U. S. Dept. of Agriculture, 1892, p. 12.

[Continued from SUPPLEMENT, No. 894, page 14290.]

THE ACHIEVEMENTS OF AMERICAN SURGERY.*

By FREDERIC S. DENNIS, M.D., New York.

IN 1821 Dr. Nathan Smith performed ovariotomy in Connecticut, and without the knowledge that it had been performed by McDowell; Smith dropped the pedicle into the abdominal cavity and thus made a great advance in McDowell's operation. In 1823 Alban G. Smith also performed an ovariotomy in Kentucky, and David L. Rodgers in New York in 1829. All these cases of ovariotomy were successful. It was seven years after this last American operation before ovariotomy was first performed in England, and nearly fifteen years before ovariotomy was first performed in France. In 1870 T. Gaillard Thomas first devised and performed successfully a vaginal ovariotomy. In 1872 Dr. Davis, of Pennsylvania, performed successfully the same operation, followed in 1873 by Gilmore, of Alabama, and in 1874 by Battey, of Georgia, and later by Sims.

In 1872 Battey performed his first oophorectomy "with a view to establish at once the change of life for the effectual remedy of certain otherwise incurable maladies." This is an operation also of purely American origin, and has contributed much to the relief of human suffering.

It has been urged that while to an American surgeon the credit is honestly due for the first performance of an ovariotomy, other nations have perfected the operation, and that more credit is due to-day to other nations for the best results. Let us see how this statement accords with facts: In 1857, the question of ovariotomy was brought up for discussion at the French Academy of Medicine, and only one surgeon considered the operation as sometimes justifiable. Up to that time there had been in America ninety-seven ovariotomies, with thirty-four per cent. mortality; in Great Britain, one hundred and twenty-three operations, with forty-three per cent. mortality; and in Germany, forty-seven operations, with seventy-seven per cent. mortality. American surgeons, therefore, not only obtained the best results up to that date, but no American surgeon to-day will concede that our results are inferior to those obtained by surgeons in any other country at the present time. Among American surgeons who are now contributing to the success of ovariotomy may be mentioned Thomas, Lusk, Polk, Wylie, Munde, Goodell, Kelly, Homans, Price, Janvrin, Leidy, and Dudley.

Few men can realize the influence of McDowell's first ovariotomy upon the whole field of abdominal surgery. It is indeed a sublime thought to consider that a man was found with the courage of his convictions to do what no man had ever done, and to operate within the noise of an infuriated mob, beneath his windows. This mob would have lynched him if Mrs. Crawford had died. Having escaped the angry mob, he was pointed out as a murderer by his fellow colleagues, and was condemned by the highest scientific authorities in Europe. In America, therefore, under such circumstances and under such conditions, the birth of the greatest operation in surgery occurred—an operation destined to save in the future millions of human lives.

The approval of this great operation of McDowell's, by the press, by the profession, and by the laity was not cordial. The *Medico-Chirurgical Review*, speaking of McDowell's achievement, says: "A back settlement of America, Kentucky, has beaten the Mother Country, nay, Europe itself, with all the boasted surgeons thereof, in the fearful and formidable operation of gastrotomy with extraction of diseased ovaries." All this vituperation was hurled at McDowell; but time, as the great arbiter, has demonstrated that what was said in sarcasm has become a transcendent and mighty truth.

The noble character and the true grandeur of McDowell's nature, and his high and lofty ambitions, are illustrated by the fact that he had performed three successful ovariotomies, operations never before undertaken by man, without heralding the victories as triumphs of his personal ambition.

In the early days of ovariotomy, McDowell and Nathan Smith, the Atlees, Dunlap, Peaslee, Kimball, Sims, and Thomas, have established and brought to the front an operation against which the most bitter and scathing invectives have been aimed. These great men, who have placed this operation upon a firm basis, deserve the gratitude of a nation, and of the world, since they have thrown a flood of light upon this dark region of surgery, which is now illuminated by the work of recent operators whose successes are simply miraculous.

The operation of hysterectomy is one that was performed very early in the history of this country, since it has been ascertained that in 1813 Joseph Glover, of South Carolina, removed the entire uterus, and the patient made a complete recovery. This operation occurred just four years subsequent to McDowell's first ovariotomy. Dr. J. Briggs also repeated the operation in 1830, and Dr. J. M. Briggs is said to have performed the same operation previous to 1830, the exact date of which is unknown.

In 1759 John Bard operated for extra-uterine pregnancy, and in 1791 the operation of gastrotomy for the same reason was successfully carried into execution by William Baynham, and again successfully in 1799 by the same surgeon. Since then the operation has been performed frequently.

In 1816 John King, of South Carolina, removed a living child, in the case of an extra-uterine pregnancy, by opening into the pelvic cavity by the side of the vagina and extracting the child with forceps.

In 1824 Jameson first incised the cervix uteri, and in 1870 T. Gaillard Thomas, and in 1876 Skene, of Brooklyn, both successfully performed gastro-elytrotomy.

In 1862 Emmet described a new operation in gynecologic surgery for the relief of lacerated cervix. This operation has contributed much to the relief of suffering in those cases which hitherto baffled medical skill. He also devised an operation for prolapsus of the uterus in 1869, and one for displacement of this organ in 1874, also one for lacerated perineum and rectocele in 1882, and one for the purpose of exploring the bladder or removing urethral carbuncle by button slit in the urethra.

To our countryman, J. Marion Sims, is due the great honor of perfecting, in 1852, the operation for the cure of vesico-vaginal fistula, and while the operation itself was not first executed in this country, it was so improved and perfected that to-day the operation of Sims is the one universally practiced.

Nathan Bozeman has also devised an operation for the relief of this condition by operating in the knee-chest position, with instruments especially devised by himself. This operation has prevented much suffering and distress which before the perfected operation of Sims was considered as practically incurable. The same surgeon also devised the operation for prolapse of the uterus in 1856, and for the relief of vaginismus in 1857, and perfected the technique of amputation of the cervix in 1859.

In closing this brief sketch of American gynecologic surgery, it is obvious that it was an American surgeon to whom the honor of first performing ovariotomy is due. Sir Spencer Wells is said to have added twenty thousand years to the lives of British women, and by the same process of reasoning, Ephraim McDowell, the Kentucky frontier surgeon, has already added hundreds of thousands of years to the lives of women throughout the world. Our country has achieved its most brilliant triumphs in this department of surgery, and to American surgeons belongs the honor of not only first performing nearly every important surgical gynecological operation, but also of perfecting the technique of the less important surgical procedures.

A most worthy compliment to American gynecological surgery is the fact that one of Great Britain's most famous ovariotomists sent his son to our shores to study and to perfect himself in gynecological surgery.

The operation of Cæsarean section has met with unusual success in this country. Lusk has operated five times with three successful results; the fourth case died of intestinal obstruction consequent upon a pelvic abscess due to Pott's disease, and the fifth died also of Pott's disease. Kelly has performed the operation five times, with four successful results. Thomas has operated with success; also Jewett, of Brooklyn, Price and Noble, of Philadelphia, Garrigues, Coe, and Grandin, of New York. Gibson performed Cæsarean section twice upon the same patient; once in 1835, and again in 1837. The patient recovered and died at the age of seventy-five. Kelly devised a new operation for the relief of retro-displacement of the uterus. The operation has been modified by Krug, in 1890, and also by Dudley, of New York. E. C. Dudley, of Chicago, has devised an operation for antero-displacements, and the same operator has also improved the Alexander operation.

Newman devised his operation for shortening the round ligaments in September, 1888.

Outerbridge, in 1889, devised a speculum for dilatation of the cervix in cases of stenosis when sterility exists.

Laparotomy was performed by Dr. Wilson, in 1831, for the relief of an intussusception. The patient was a negro slave, and had suffered from intestinal obstruction for seventeen days. The abdomen was opened, the intussusception was found, and it was drawn out and released, and the patient made a complete recovery.

In 1792 Physick devised an operation for the cure of artificial pouches in the alimentary canal.

In 1809 Physick was the first to ligate the eperon, where an artificial opening had been made in the intestine on account of pathological changes. In 1847 Gross urged the excision of a section of the intestine with suturing of the divided ends, with a view to establish the continuity of the canal, but the patient refused, and in 1863 Kinloch, of South Carolina, accomplished this result.

In 1834 Luzenberg laid open a strangulated hernia, found it gangrenous, excised the mortified section of the intestine, stitched the serous surfaces, and the patient fully recovered. This same surgeon suggested, in 1832, exclusion of light to prevent pitting in smallpox.

The operation of laparotomy for the treatment of penetrating gunshot and stab wounds of the peritoneal cavity was the work of American surgery. Gross, in 1843, and Sims, just before his death, both suggested this method, but these gentlemen never practiced this method of treatment. It remained for Dr. W. T. Bull to make the practical application of the method, and to him is due the credit of this great advance in surgery. It is a source of national pride that laparotomy in penetrating wounds and visceral injuries of the abdomen was conceived, developed, and perfected in America. The wide-spreading influence of this operation is felt in abdominal surgery, and much of the present advance is the result of Bull's surgery. The work of Senn and Abbe in intestinal anastomosis deserves the highest praise.

The operation for the relief of acute appendicitis is clearly traced to the work of American surgeons. In 1843 Willard Parker, and later Gurdon Buck, did much to explain the nature of these iliac inflammations, and Sands cleared the way for the perfected operation of McBurney, which aims to prevent these dangerous peritoneal inflammations, and prepare the wound for aseptic healing. Sands also first operated with success after perforation had taken place and general peritonitis was present. To McBurney is due great credit for the perfection of this operation, which is now recognized throughout the world as the best, safest, and most scientific way of managing these varieties of suppuration hitherto so fatal.

The operation of removing the appendix vermiformis during the quiescent period between relapsing attacks was suggested by Treves, of London, although the appendix was successfully removed in this country by the writer in 1887. In this case the appendix was diseased, owing to adhesions to an ovarian tumor.

The first and only successful case of laparotomy for the relief of perforation of the intestine during the progress of typhoid fever was performed in this country, and to Dr. Weller Van Hook, of Chicago, is due the credit of having first established an operation for the relief of these cases, which hitherto were fatal.

Still another important discovery must not be overlooked, and that is Senn's insufflation of hydrogen gas as an infallible test in the diagnosis of visceral injury of the gastro-intestinal canal in penetrating wounds of the abdomen. Senn has also made other valuable contributions to abdominal surgery. Indeed, Senn's work entitles him to the gratitude of the profession.

Laparotomy for the relief of purulent peritonitis was performed by Mears, of Philadelphia, in 1875. This case is one among the first, if not the first, where the peritoneal cavity was opened for the express purpose of washing it out and draining it as any abscess cavity. The work of Abbe, Hartley, Curtis, McCord, Briddon, Lange, Stimson, Morton, and Vanderveer deserves great commendation.

In surgery of the liver American surgeons have distinguished themselves. In 1867 Dr. Bobbs, of Indianapolis, was the first surgeon to perform the modern operation of cholecystotomy, which he did successfully, and removed fifty biliary calculi from an incision into the gall bladder. He was soon followed, in 1868, by Dr. J. Marion Sims, who removed sixty stones from the gall bladder. To Tait, however, belongs the great credit of perfecting the technique of this operation, and he stands to-day pre-eminently the great authority upon hepatic surgery.

Excision of biliary calculi by incision into the umbilical vein was performed by Dr. John C. Warren, of Boston, in the early part of the present century.

In the surgery of the spleen American surgeons have a record of which they need not be ashamed. In reviewing the literature of splenectomy the case of Zaccarelli, in 1549, may be excluded, Sir Spencer Wells says, as apocryphal. The next authentic case is one by Quittenbaum, of Rostock. This splenectomy was performed in 1826, and the patient died. But in 1861, a quarter of a century previous to this case, Dr. Joseph Glover, of Charleston, S. C., removed nearly the entire spleen, some omentum, and ligated a branch of the splenic artery. This was not, however, an extirpation of spleen due to any pathological cause. The spleen was also removed for gunshot wound, by Dr. Alston, of Texas, about 1863, and the patient recovered.

What little has been done in the surgery of the pancreas has been done by American surgeons. The literature of the subject is contained in an elaborate brochure by Senn.

There have been only four cases of cysts of the pancreas diagnosticated, and these were operated upon successfully by Senn, Tremaine, Bull, and Bozeman.

4. *Surgery of the Genito-Urinary System.*—In the department of genito-urinary surgery a great advance has been made by the invention of instruments to facilitate and improve the technique.

The cystoscope is an American instrument, having been invented by Dr. John D. Fisher, of Boston, in 1824, Civiale and Heurteloup having invented their instruments in 1827. The cystoscope of to-day is the one which has been evolved from the general principle of Fisher's endoscope.

W. T. Otis has perfected the urethroscope by the addition of a new lamp for the electro-urethroscope. Klotz has also devised a cystoscope which is in use at the present time.

Dr. F. T. Brown has devised a most useful urethral speculum for the purpose of making topical application to the canal.

The Gross urethrotome, also Powell's urethral dilator, and the Otis dilating urethrotome, and the urethrotometer, are instruments deserving of worthy mention. The work of Bumstead and of Van Buren in this department of surgery has already a world-wide reputation.

The operation of nephrectomy, for the relief of malignant disease of the kidney, is of American origin, since it was first performed by Wolcott, of Milwaukee, in 1860. British surgeons give the credit of this operation to Simon, of Heidelberg; but he did not perform his operation until 1869, or nine years after Wolcott's operation.

Nephrectomy was first performed in America for gunshot wound of the kidney, by Keen, in 1887, and again two months later, for the same reason, by Willard, and still again for the same cause, by Price, successfully, in 1888.

The first successful operation for the relief of extroversion of the bladder was performed in this city by Dr. A. L. Carroll, on April 13, 1858. Pancoast performed the same operation successfully the same year, and Ayers in 1859. All of these cases antedate the British successes of Woods and Holmes, although there are two operative failures reported by Cook and Lloyd in London, in 1851. Rupture of the bladder was operated upon successfully by a laparotomy by Walters, of Pittsburg, in 1862, but to Sir William MacCormac is justly due the credit of establishing this operation.

In plastic surgery of the urethra another brilliant triumph has been made by American surgeons. In 1892 Dr. Sam Alexander has succeeded, for the first time in the history of genito-urinary surgery, in making a new urethra, the retentive powers of which were perfect, in a case of complete epispadias in the female. There have been twelve cases in all of complete epispadias, in none of which heretofore has the urine been completely under the control of the patient.

In 1795 Physick did an internal urethrotomy by a concealed lancet, and Alexander Stevens, in 1817, was the first surgeon in this country to perform external perineal urethrotomy. He revived the operation which had fallen into desuetude, since at the close of the last century the mortality was so great that the operation was practically abandoned. Prior to 1840 the operation was performed in this country by several surgeons; notably, in 1820, by Jameson, in 1823, by Rodgers, in 1829, by Warren, and later by several surgeons connected with the New York Hospital, among whom may be mentioned Hoffman, Post, and Watson, and also by Alden March, of Albany, and Wood, of New York City.

Without doubt the operation has reached its present state of perfection through the labors of Gouley, who suggested the whalebone guide, the tunneled catheter staff, and the beaked bistoury.

The operation of Fluhrer with his instruments, which are marvels of mechanical skill and precision, has still further improved the technique of external perineal urethrotomy.

The operation of supra-pubic prostatectomy was first performed in this country by Belfield, in October, 1886.

This operation has been greatly improved upon by the use of Gouley's prostatectome, which facilitates the removal of the gland.

In lithotomy American surgeons have achieved brilliant results.

* From the *Medical Record*, New York.

McDowell did 32 lithotomies in succession without a death. Dudley performed 100 consecutive operations without a fatal case. In 1846 Willard Parker removed a calculus from the bladder by producing a recto-vesico fistula, and subsequently performed this operation for the cure of chronic cystitis, and in 1861 Dr. Bozeman did this same operation to relieve a chronic cystitis in the female.

Physick did his first operation for stone in 1797, and in doing it wounded the internal pudic artery, which accidentally led to the invention of his needle for the purpose of carrying a ligature around deep-seated vessels. In 1836 this same operator removed over 1,000 calculi from the bladder of Chief Justice Marshall.

These brilliant results in lithotomy are most remarkable when it is considered that there was a time in the medical history of this country when a patient actually made the pilgrimage across the ocean in order to secure the services of a surgeon to perform lithotomy.

In lithotrity, American surgeons have obtained results such as would compare favorably with the work of lithotrotists of other countries. Keyes has made some great improvements in litholapaxy, thereby reducing the mortality of the operation, among which may be mentioned the evacuating tube, the alteration in the mechanism, and other improvements in the technique of the operation.

To Henry J. Bigelow, of Boston, is due the credit of having made important changes in the technique of lithotrity. In 1878 Bigelow pointed out the important fact that a calculus could be crushed and the debris removed at a single operation. This was a great step forward, and litholapaxy of to-day is an operation of American origin, since Bigelow devised a lithotrite for crushing the stone and an evacuator for washing out the bladder after ablution.

This operation of Bigelow's has been performed by Keegan 59 times in children, with one death, and by Freyer 49 times, without a death.

The record of Bigelow's, or the American operation of litholapaxy, has certainly won for itself a fixed place in the annals of surgery.

5. *Miscellaneous Operations.*—There are many miscellaneous operations in surgery which are purely of American origin, or they have been so improved in technique as to be properly claimed as American. The scarification of the infiltrated mucous membrane in œdema glottidis, as suggested by Buck, and the removal of polypi from the larynx by the same surgeon, who was the first to do this in America and the second in the world, is worthy of record.

Frank Hamilton, in 1854, was the first to transplant skin for the repair of ulcers. This operation he termed anaplasty.

In October, 1842, Sayre made a free incision in the chest in a case of empyema and the patient made a good recovery. Forty years ago Sayre raised the inquiry, "In the empyema of a tuberculous patient from the rupture of an abscess into the pleura, would we not be justified in tapping as soon as discovered?"

In 1850 Dr. Henry I. Bowditch suggested and practiced paracentesis thoracis. Dr. Morrill Wyman, unaware of Dr. Bowditch's operation, performed the same operation. For a long time in this country, as well as in Europe, paracentesis thoracis was condemned; but at last the operation has advanced to the stage of full acceptance by all surgeons. It is almost impossible to estimate the number of lives saved by this operation, but the number is very great, and this operation forms an enduring monument to the fame of these American physicians.

In 1844 John Watson performed œsophagotomy for the relief of organic stricture of the œsophagus, and in 1886 Richardson demonstrated the accessibility of the entire length of the œsophagus by digital examination, either by gastrotomy or œsophagotomy.

In 1823 Milton Antony removed a diseased rib and a large portion of lung tissue, and evacuated a lung abscess. This is one of the first operations upon the lung.

In the surgery of the eye important work has been accomplished by specialists, but they have done very little original work, the revival of old operations, the improvement in the technique of existing operations, and the magnificent results obtained by Agnew, Noyes, Knapp, Bull, Loring, Kip, Callan, Carmalt, and Roosa characterize this department of surgery.

The introduction of cocaine as an anæsthetic, by Koller, now of this city, but who made his discovery in Vienna while a student, is one of the most important discoveries of the century, and the application of this drug to produce prolonged anæsthesia in a part by pressure sufficient to retain the cocaine within prescribed limits, as pointed out by Dr. Leonard Corning, is a most remarkable discovery. The discovery of water as a local anæsthetic was made in 1885 by Halsted, of Baltimore.

In the surgery of the ear important work has also been accomplished. Removal of the ossicles by Sexton and Burnett, removal of the stapes by Blake, the operation for correction of prominent auricles by Keen and Monk, the invention of the artificial leech by Bacon, and the operation of trephining the mastoid cells, as performed by Crosby, Alfred Post, Agnew, Buck, Knapp, Roosa, Gruening, and Pomeroy are among the chief operations.

In the surgery of the nerves the work performed by Americans is most commendable.

In 1869 Warren, of Baltimore, excised the head of the humerus to relieve severe brachial neuralgia produced by pressure of the dislocated head upon the plexus.

In 1876 Mears subcutaneously divided the humerus and thus produced a false joint. In 1871 Sands excised a piece of the brachial plexus for the relief of persistent neuralgia of a traumatic character.

In 1856 Carnochan excised the second branch of the fifth cranial nerve beyond Meckel's ganglion, for the relief of tic douloureaux, and two years later Pancoast performed the same operation in the pterygo-maxillary fossa.

In 1863 Gross removed the inferior maxillary branch of the same nerve.

In 1873 Morton dissected out the perineal nerve for intense neuralgia of the parts to which it is distributed. The same operator cut out nearly two inches of the sciatic nerve to relieve elephantiasis in a patient upon whom he previously had performed Carnochan's operation of ligation of the femoral artery.

S. W. Gross, for the first time in the history of surgery, excised nearly two inches of the spinal accessory nerve, and performed tenotomy of the sterno-cleido-mastoid muscle to cure torticollis.

In 1870 Dr. Sayre pointed out the relation between paralysis and peripheral irritation as observed in congenital cases of adherent prepuce.

The telephone is an American invention, the application of the principles of which has been made to practical surgery. The author reports a case of an intubation tube which had by accident fallen into the trachea, and which was removed by him as soon as the lodgment of it was made certain by the telephone needle probe devised by Girdner, of this city. The wonderful ingenuity displayed by the American mind has resulted in some great achievements in surgery through the instrumentality of electricity. It is only necessary to refer to the many valuable instruments now daily employed by surgeons, and to the various uses to which this great agent has been subjected in every branch of surgery, to appreciate the inestimable blessings of electricity to general surgery.

Amputations.—In this department of surgery America has nothing of which to be ashamed. She has not only taken the initiative in the more important amputations, but she has perfected methods devised by eminent surgeons in other countries throughout the entire world. The first successful primary amputation at the hip joint was performed by a Kentucky surgeon named Brashear, in 1806. The amputation was repeated with success by Mott, in 1824.

Nathan Smith was among the first, if not the first, to successfully and systematically amputate at the knee joint, in 1824, and the technique of this operation has been perfected by Markoe and Stephen Smith, of this city.

The first successful amputation of the ankle joint in this country was performed by Gross, in 1851. The operation had been performed in 1842, by Syme, in Scotland.

The first systematic amputation at the shoulder joint was performed by Richard Bayley, in 1762. The same operation was also performed by John Warren, in 1781.

The first successful amputation of the arm, with the clavicle and scapula, was performed by Dixi Crosby, in 1836. Amos Twitchell and MacClellan performed the same operation successfully in 1838.

Triple simultaneous amputations have been successfully performed by Ashhurst, Ruckie, Stone, Reid, Koebler, and others, while Wallace has successfully performed a quadruple amputation. These are among the curiosities of surgery, and illustrate the preservation of human life in the face of the greatest danger.

Thus it is evident that American surgery has not only taken the initiative, but has successfully performed many of the major amputations; and when the number of them is considered, what has been left for other countries to claim in regard to this special field of operative surgery? In the invention of prothetic apparatus, the ingenuity of the American mind has discovered a most wonderful field of operation, since in no country can be found the mechanism that is displayed in the manufacture of aluminum artificial limbs. I know of patients who can walk well, and even run, with two artificial limbs, and one who has artificial hands who is employed as a pharmacist and weighs medicine on the most finely adjusted balance.

Staphylorrhaphy was performed by Dr. John C. Warren, in 1820, the same year, it is just to state, that the operation was performed in France by Roux, but Warren had no knowledge of Roux's method. It has been also stated that this operation had been previously executed in Poland; but no authentic statement is extant as to who the surgeon was, or at what place or time the operation was performed.

Myotomy of the masseter muscle was first performed by Schmidt, of New York, and followed by Mutter, of Philadelphia. Both of these operations preceded the work of Dieffenbach and Fergusson.

Excision of the tonsil was an operation placed upon a permanent and safe basis by Dr. Cox, of New York. This surgeon invented, in 1820, an instrument which included the tonsil in a ring, and then cut it by a ring-shaped knife. The guillotine principle applied to the tonsillitome was an improvement upon this instrument.

Previous to 1820 the method of Desault was in vogue, which consisted in tying off the tonsil, and permitting it to separate by sloughing for six days.

The evolution of the present guillotine tonsillitome is one of great interest. Dr. John C. Warren, of Boston, about 1835, attempted to remove the tonsils of Mr. Caleb Eddy's boy, and the instrument worked so unsatisfactorily that Mr. Eddy remarked to Dr. Warren at the completion of the operation that this crude instrument was "Sullivan's machine," and that he would make one for him better adapted to the purpose. In order to appreciate this terse and sarcastic remark, it is necessary to recall some historical facts.

In the old Salem canal the grass grew so luxuriantly that it impeded the progress of the slow canal boats, and Mr Sullivan, the superintendent, devised a machine known afterward as "Sullivan's machine," which consisted of a sort of a scythe which was set upon a frame and attached to the stern of the canal boat, and as the canal boat was hauled through the waterway, the grass was supposed to be cut by the blade swung from the stern of the boat. As a matter of fact, the grass was simply pushed down in front of the knife instead of cutting it.

Mr. Caleb Eddy, appreciating the mechanical defects of this cutting apparatus, suggested placing the knife at an angle, and then the grass was cut down as the boat was dragged through the canal. The guillotine tonsillitome was then constructed according to the present plan, which received its suggestion from Mr. Eddy, who, seeing the error in "Sullivan's machine," devised an ideal one which worked effectually upon mechanical principles, and from the old Salem canal boat the suggestion was derived for the perfection of the present perfect tonsillitome of to-day.

I have been very much surprised to find how many surgical instruments have been derived from such an incident or event just narrated. The American mind is wonderfully prolific in invention, and the same genius in the medical world has adopted, improved, and perfected many a surgical instrument from the mechanics of everyday life. The whole armamentarium of surgery is an evolution, and to trace the origin and growth of the mechanics of surgery is a subject fraught with a fascinating interest.

In the departments of throat and nose, American surgery has accomplished excellent results. The operation for the relief of catarrh by the use of the saw invented by Bosworth, and also one by Bucklin; the removal of polypi by the snare devised by Jarvis; the cure of nasal stenosis by the nasal trephine, by Curtis; the improvement of Elsberg's forceps by Beverley Robinson, all deserve the highest commendation. In 1866 Cheever, of Boston, was the first surgeon to remove a carcinomatous tonsil by an operation through the neck. The work of Bosworth, Lincoln, Chapman, Delavan and Vander Poel in this department also deserves special commendation. Tiffany, in 1878, removed successfully a naso-pharyngeal polypus by first depressing temporarily the two upper jaws, having performed a prophylactic tracheotomy.

The operation of intubation is one that reflects great credit upon American surgery. The dyspnœa of laryngeal stenosis depending upon the pressure of a pseudo-membrane, or a stenosis the result of a chronic inflammatory thickening, are relieved by the introduction of a tube through the mouth into the larynx. This is not the place nor the occasion to enter upon the merits or demerits of intubation of the larynx as compared with tracheotomy. Suffice it to say, however, that the awful dyspnœal distress among children suffering from croup or diphtheria has been in a large measure relieved, and the mortality of the operation, based upon 806 cases, 27·4 per cent. This mortality is the result obtained from a list of the cases furnished by many operators, while in individual operations the result has been as high as thirty-eight per cent. of recoveries.

Few can realize the wide-spreading influence of this operation for the relief of one of the most dreadful of diseases. To Dr. Joseph O'Dwyer the entire profession owes a debt of gratitude. "The perseverance, ingenuity, and originality shown in perfecting the method merit our admiration." Finally, I heartily indorse the sentiment expressed by Dr. Ingals, and join "in acknowledging the nobleness of the profession at large, which tolerates no secret method, but generously donates to mankind every improvement in the healing art. Among the latest, but not the least, may be classed intubation, rightly considered as one of the great advances of medical discoveries."

In considering this great discovery and invention by Dr. O'Dwyer, the long list of brilliant operators who have perfected and demonstrated the success of the operation deserve recognition, among whom may be mentioned Dillon Brown, who has intubated six hundred and sixty-eight cases, with a little over thirty per cent. of recoveries; also Waxham, Huber, Eichberg, Montgomery, Gay, McNaughton, Pyne and others, have performed many intubations with brilliant success.

In the investigation of malignant tumors American surgeons have displayed great ability. The early work of Warren, of Boston, was among the first attempts to systematically collect and study neoplasms from a clinical point of view. The writings of Gross upon tumors demand more than a passing notice, while the contributions of Shrady and of Mudd to cancer of the tongue are most exhaustive. A striking illustration of the results after operation in carcinoma of breast affords an example of what has been accomplished in this country, since the percentage of permanent recoveries has now reached over thirty per cent. as contrasted with the fourteen per cent. which represents the best results in Great Britain. In sarcoma the results are even more favorable. J. Collins Warren's method of examining a part of a tumor before operation by his special instrument is a most useful and ingenious invention. The work of White in the surgery of the spinal cord, of Watson in concussion of the cord, of Westbrook in tapping the ventricle of the heart, of Gerster, Pilcher, and Fowler in perfection of antiseptic technique, of Dawbarn in hypodermatic injection of serum in large blood vessels as a substitute for transfusion — all deserve special commendation. The writings of Agnew and Ashhurst, which have widely disseminated surgical literature, the investigations of Jarvis White upon the subject of asymmetry of limbs, the work of Yale in tuberculosis of joints and bone, and of Ranney in the surgery of the nerves also deserve most honorable mention.

In plastic surgery American operators have been most successful in their work. The formation of a nose from the forehead by the modified Indian method by Pancoast, and the building of a nose from the phalanx by Sabine, the treatment of cicatrices after burns by Mutter, are all operations illustrating the versatile genius of the American mind. The plastic surgery of the mouth has been advanced by Goodwillie, whose results in this department of surgery have been presented to the profession.

In the invention, perfection, and manufacture of surgical instruments America eclipses the world. It was my intention to collect for the purposes of practical demonstration a sample of every surgical instrument invented and made as a result of Yankee ingenuity; but I was informed that over one hundred thousand dollars would not cover the expenses of such an outlay. I have, therefore, been obliged to abandon that project in full and have arranged to show as many as possible of the modern instruments of purely American invention, in order that the members of this association could form some general idea of the credit to which our country is entitled for their share in the armamentarium of the surgeon. It is certainly a most praiseworthy fact that there is no operation in all surgery that cannot be performed by instruments invented in this country and manufactured by American artisans. This statement embraces a wide field, and an examination of the array of surgical instruments will convince any one of the correctness of this opinion. It is but a short time since the French imported surgical instruments were almost a necessity; but nowadays the most perfect and precise instrument is made in our country and with steel that eclipses that of any other nation. For workmanship, for precision, for lightness, for durability, for strength and beauty, the work of American artisans is superior to that of any other country.

The impartiality of our countrymen has enabled us to seize upon the best from wherever it emanates. American surgeons have gleaned the harvest from all nations. During our colonial days Great Britain and

France were foremost in the achievements of surgery, but their feelings of hated rivalry and national jealousy precluded the possibility of their adopting anything good from one another. In late years this same spirit pervaded France and Germany. The want of reciprocity has hindered the advance of surgery in both of these rival nations. As an illustration of this statement can be cited the fact that in 1823 the writings of the great French surgeon Desault had never been translated for the use of English surgeons, while at that time Dr. E. D. Smith, of South Carolina, was engaged in the translation of that work for the benefit of American surgeons. In this great triangle of nations, formed by England, France, and Germany, the good of each remained within its own domain. America, on the other hand, eagerly seized upon all the good from these and other nations, and she appropriated to her own use all principles, theories, discoveries, inventions, and knowledge, and utilizing these factors, she has made her onward march illustrious.

With the wonderful adaptability of the American mind, with its easy susceptibility in its early plastic condition, these impressions have been made and their results in surgery are as enduring in their potential influence as the ocean which separates us from the Old World.

Finally, gentlemen, this brief review of the early and present achievements of American surgery demonstrates the fact that our country has nothing of which to be ashamed in estimating her share in the evolution of this great science. Our contributions to surgery in general are now matters of record for the study of all nations. If what America has accomplished in the past be eliminated from the sum total of the surgical work of the world, there is little left to the older nations.

There are many things which explain the prominent position which America has taken in the consummation of this great work. Chief among them may be mentioned the innate courage which our Puritan ancestors possessed. The same undaunted bravery that spurred the Puritans to cross the great unknown ocean and to settle in the primeval forest for the purpose of exercising their liberty stirred them to great efforts on behalf of surgery and made them fearless and bold. The self-reliance of the early settlers in this country and their manly independence were characteristics necessary to win success in the art of surgery, without which American surgery would never have obtained the high place it has in the estimation of the civilized world.

HOW ORE IS PURCHASED.

IN reply to a correspondent who asked how smelters figure on the smelting charge on ore, or the price to be paid for it, the *Mining Industry and Tradesman* gives herewith the usual rule. Different smelters vary the method a little, but reach practically the same result.

The ore, when it is received, is analyzed for silica, iron, lime, zinc, manganese, or other metalloids or metals it may contain in addition to its assay for gold, silver, lead or copper. Each of these ingredients is beneficial or injurious in a smelting charge. Those which are beneficial are credited with a certain amount for each unit, or per cent. in which they occur in an ore, and those which are injurious are charged with a certain per cent. Silica and zinc are charged for, and iron, lime, gold, lead, and copper, when the three latter occur in quantities too small to be paid for, are all credited with some value. Under the scale of prices adopted by smelters, lead, when it occurs in a less quantity than 10 per cent., is not paid for. The same is true as to copper below 2 per cent. and gold below one-twentieth of an ounce per ton. The miner usually supposes that on account of this schedule of prices he is never paid for these metals his ore may contain, if their quantity falls below the percentage or value stated But he does get pay, in lower smelting charges.

As for silica and iron, equal quantities of each are counted as offsetting each other. If an ore contains more silica than iron, it carries an excess of silica, and each unit or per cent. of the excess is charged for. If it carries more iron than silica, the excess of iron is paid for on the same basis. At the present time iron excess is generally paid for at the rate of 15 cents for each unit, and the excess of silica is charged for at the same rate.

Let it be assumed that an ore carries silica 30 per cent., iron 20 per cent., lead 8 per cent., zinc 12 per cent., gold 0·04 of an ounce, and silver 100 ounces per ton. The balance is sulphur, which is mostly eliminated by roasting, for which there is a uniform charge on all ore requiring roasting of $2.50 per ton. In estimating the cost of smelting, the charge against the ore would be as follows:

10 per cent. silica excess	$1.50
12 per cent. zinc	6.00
Roasting	2.50
Smelting	4.50
Total	$14.50

The credits would be:

8 per cent. lead at 20 cents	$1.60
0·04 gold at $19 an ounce	.76
100 oz. silver at 82 cents less 5 per cent.	77.90
	$80.26
Less	14.50
Price paid per ton	$65.76

As usually stated, the silver only in such ore would be paid for at 95 per cent. of its New York quotation on the day of sale. That quotation would make its value, as stated, $77.90 per ton, and there would be paid for it $65.76 per ton, making the apparent smelting charge the difference between the two, or $12.14 per ton. It will be seen that the owner of such ore gets pay for its lead and gold contents, notwithstanding the buyers do not profess to pay for them when they are found in these small quantities.

Of course ore buyers vary their bids for ore, just as they may need the particular ore on which they are bidding. One smelter may need a siliceous ore, while others do not. In that case the smelter requiring such ore might not charge the silica excess with $1.50, in which case his apparent smelting charge would be less than that of other smelters which laid upon it that charge. Again, a smelter might be in such great need of lead ore that he might be willing to credit the ore with more than 20 cents for each unit of its lead contents, even though it fell below 10 per cent.

Again, when different smelters are bidding on a lot of ore, as they do on all lots sold through the public sampling works, each one making his own analysis, there may be a difference in the analysis on silica, zinc, iron or any other of its contents, of even 1 per cent. or a fraction of an ounce of silver, and in such cases there will be a corresponding difference in bids, from men who calculate on the same basis, at the same prices. It is thus that bids on the same ore may differ considerably.

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